Space Station Manned Base (SSMB) to Mobile Servicing System (MSS) Interface Control Document Part I

International Space Station Program

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INTERNATIONAL SPACE STATION PROGRAM

SPACE STATION MANNED BASE TO MOBILE SERVICING SYSTEM INTERFACE CONTROL DOCUMENT PART I

MAY 22, 1997

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INTERNATIONAL SPACE STATION PROGRAM

MOBILE SERVICING SYSTEM (MSS) TO USER INTERFACE CONTROL DOCUMENT

MAY 22, 1997

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PREFACE

SSP 42003, Space Station Manned Base (SSMB) to Mobile Servicing System (MSS) Interface Control Document (ICD) Part I shall be implemented on all new Program contractual and internal activities and shall be included in any existing contracts through contract changes. This document is under the control of the Space Station Control Board (SSCB) with the concurrence of Canadian Space Agency (CSA), and any changes or revisions will be approved by the SSCB and CSA.

Program Manager, International Space Station	Date

INTERNATIONAL SPACE STATION PROGRAM

SPACE STATION MANNED BASE TO MOBILE SERVICING SYSTEM INTERFACE CONTROL DOCUMENT PART I

LIST OF CHANGES

MAY 22, 1997

All changes to paragraphs, tables, and figures in this document are shown below:

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
			TABLE(S)
			FIGURE(S)
			APPENDIX(ES)
			ADDENDA

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FIGURES

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1.0 INTRODUCTION

The Space Station provides a Mobile Servicing System (MSS) to assist in the assembly and external maintenance of the Space Station. The MSS is used to transport hardware and payloads about the Space Station and support Extravehicular Activity (EVA) operations.

The flight segments of the MSS consist of the Mobile Remote Servicer Base System (MBS), the Space Station Remote Manipulator System (SSRMS), the Special Purpose Dexterous Manipulator (SPDM), and the Artificial Vision Unit (AVU). The Space Station Manned Base (SSMB) Mobile Transporter (MT) provides the mobility function for the Mobile Remote Servicer (MRS) which comprises the MBS and the SSRMS. The SSRMS and SPDM provide the capabilities to support Space Station assembly, maintenance, servicing, and EVA. The MSS Control Equipment (MCE) consists of hardware and software to control the MSS.

1.1 PURPOSE AND SCOPE

This Interface Control Document (ICD) defines and controls the interfaces between the Space Station and the Mobile Servicing System. Chapter 3 of this ICD is divided into seven sections (A, C, D, E, F, G, and H) as shown in Figure 1.1–1.

1.1.1 SECTION A PURPOSE AND SCOPE

Definition and control for the SSMB to MBS is in Section A. This section of the ICD defines and controls the interface requirements between the SSMB and the MBS. The MBS interfaces with the EVA Portable Workplatform (PWP) are defined in Section E of this ICD.

1.1.2 DELETED

1.1.3 SECTION C PURPOSE AND SCOPE

The AVU to US Laboratory interfaces are in Section C. Section C of the ICD defines and controls the physical, electrical, and functional interface requirements between the AVU and the USL. Note, the AVU CCD to RWS interface is defined in Section G.

1.1.4 SECTION D PURPOSE AND SCOPE

Section D defines the interfaces associated with the SSRMS operating from a Power and Data Grapple Fixture (PDGF) attached to ISS pressurized modules. This section of the ICD defines and controls the physical, electrical, and functional interface requirements between the PDGF, and the PDGF harness with a module to support SSRMS and SPDM stand–alone operations. The specific structural, mechanical, and electrical attachments for the PDGFs, and the PDGF harness on the various modules requiring a PDGF for SSRMS or SPDM operation will be defined in Part II of this ICD. PDGF interfaces with users and payloads are defined in SSP 42004, MSS to User ICD.

1.1.5 SECTION E PURPOSE AND SCOPE

Section E defines the interfaces between the EVA Portable Workplatform (PWP) and the MBS. The interface when the PWP is stowed or transported is between the MBS PWP Worksite Interface Fixture (WIF) and the PWP.

1.1.6 SECTION F PURPOSE AND SCOPE

Section F defines the interfaces between SSMB and the SSRMS for launch and relocation. This section of the ICD defines and controls the physical, electrical, and functional interface requirements between the SSMB Launch Support Assembly (LSA) and the SSRMS and associated Flight Support Equipment (FSE).

1.1.7 SECTION G PURPOSE AND SCOPE

Section G defines the AVU CCD to RWS interfaces. The interfaces between the AVU and the USL are defined in Section C of this ICD.

1.1.8 SECTION H PURPOSE AND SCOPE

Section H defines the interfaces associated with the Video Signal Converter (VSC). The VSC is used in conjunction with the PDGF to support relocated SSRMS operations on the modules. The VSC is also used on the S0 segment to convert fiber optic video from the external video switch to copper for the Trailing Umbilical System (TUS). This section of the ICD defines and controls the physical, electrical, and functional interface requirements between the SSMB and the VSC.

1.2 PRECEDENCE

In the event of conflict between the International Space Station System Specification and this ICD, the requirements in SSP 41000, the International Space Station System Specification shall take precedence.

1.3 CHANGE AUTHORITY

The responsibility for assuring the definition, control, and implementation of the interfaces identified in this document is vested with the National Aeronautics and Space Administration (NASA) International Space Station Program Office and with the Canadian Space Agency (CSA). This document shall be formally approved and controlled in accordance with the provisions of SSP 30459, International Space Station Interface Control Plan.

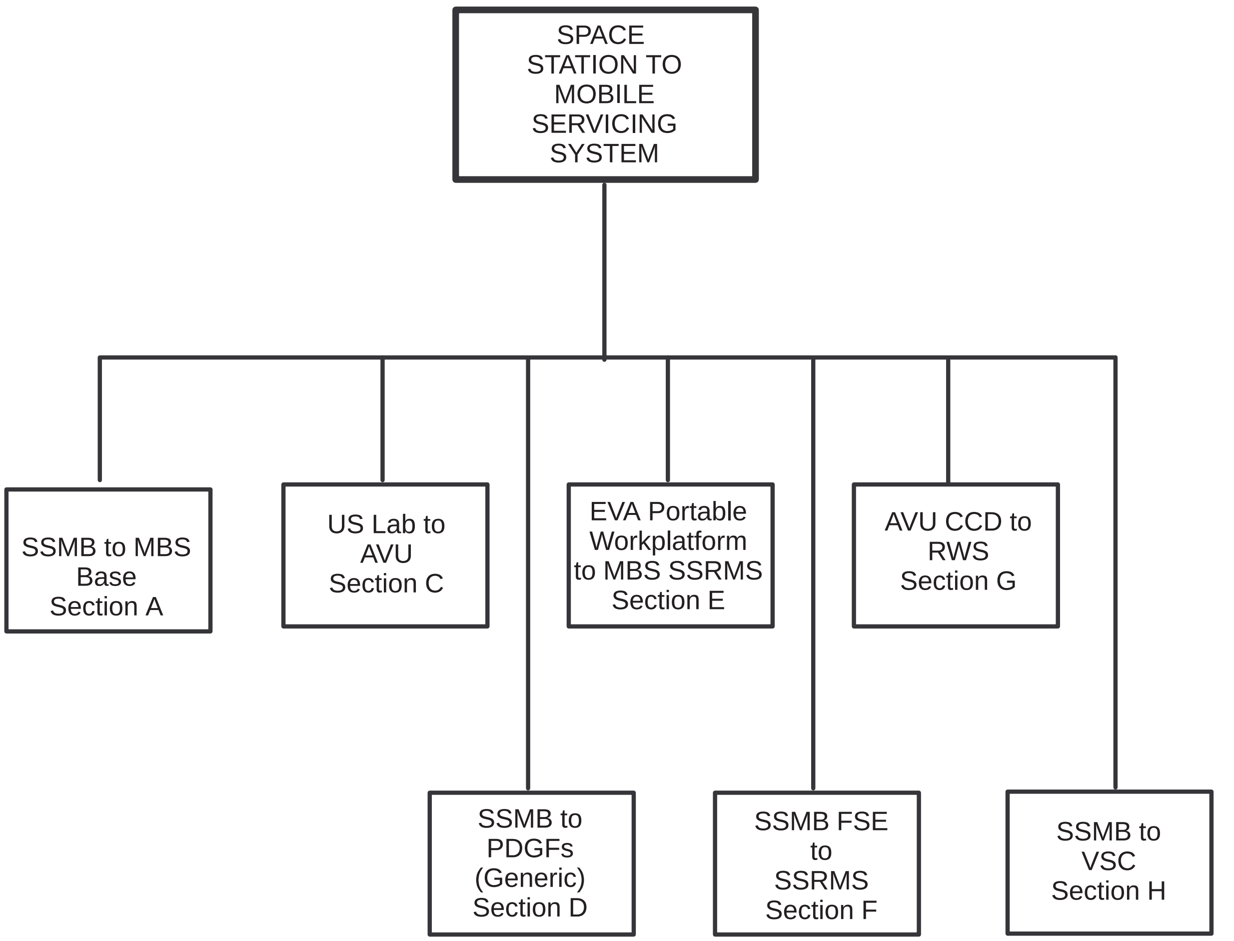


FIGURE 1.1–1 SPACE STATION TO MOBILE SERVICING SYSTEM ICD SECTIONS

2.0 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents of the exact date and revision shown form a part of this ICD to the extent specified herein.

DOCUMENT NO.	TITLE
ANSI Y 14.5M–1982	Dimensioning and Tolerancing
ASTM E380 Rev A 1 Jan 93	Standard Practice for use of the International System of Units (SI)(The Modernized Metric System)
CSA–SS–ID–0002 Draft 30 Sept 1996	Canadian Space Vision System (CSVS) Interface Control Document (ICD) MRSC/AVU
EIA–RS–170 Rev A 1 Nov 77	Electrical Performance Standards for Television Studio Facilities
MIL–38999	
MIL–STD–1553 Rev B, Notice 2 8 Sep 86	Digital Time Division Command/Response Multiplex Databus
SSP 30219 Rev D 21 Jan 94	Space Station Reference Coordinate Systems
SSP 30237 Rev B 3 Jun 94	Space Station Electromagnetic Emission and Susceptibility Requirements
SSP 30238 Rev B 3 Jun 94	Space Station Electromagnetic Techniques
SSP 30240 Rev B 3 Jun 94	SSP Grounding Requirements
SSP 30242 Rev C 3 Jun 94	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
SSP 30243 Rev C1 1 Jul 94	Space Station System Requirements for EMC

SSP 30245 Rev B 3 Jun 94	Space Station Electrical Bonding Requirements
SSP 30256:001 Rev E 3 Oct 94	EVA Standard Interface Control Document
SSP 30258:006 Current Issue	Internal TCS Coldplate Set Interface
SSP 30263:001 Current Issue	External DDCU Standard
SSP 30263:002 Current Issue	Remote Power Controller Module (RPCM) Standard Interface Control Document
SSP 30459 Rev F 23 Mar 94	International Space Station Interface Control Plan
SSP 30482 Rev A, CN–001 1 Jan 1994	Electrical Power Specification and Standards: Vol I, Electrical Performance Specifications
SSP 30482 Rev A, CN–001 1 Jan 1994	Electrical Power Specification and Standards: Vol II, Consumer Constraints
SSP 30512 Rev C 3 Jun 94	Space Station Ionizing Radiation Design Environment
SSP 30513 Rev B 3 Jun 94	Space Station Ionizing Radiation Environment Effects Test and Analysis Techniques
SSP 30559 Rev B 30 Jun 94	Structural Design and Verification Requirements
SSP 41000 Rev C 1 Nov 94	International Space Station System Specification
SSP 42004 Current Issue	MSS to User (Generic) ICD
SSP 50002 Rev Basic 15 Sep 94	ISS Video Standard

SSP 50005 Rev B 9 Aug 95	ISS Flight Crew Standard
SSP 50098 5 Dec 95	Robotic Workstation to Space Station Manned Base Interface Control Document, Part I
SSQ 21635 Rev C	General Specifications for Connectors and Accessories, Electrical, Circular, Miniature, IVA/EVA/Robot Compatible, Space Quality
SSQ 21653	General Specifications for Cable, Coaxial, Twinaxial, and Triaxial, Flexible and Semirigid
SSQ 21654	General Specifications for Cable, Fiber Optic, Single Fiber, Multi–Mode, Flexable, Space Quality
SSQ 21655 Rev C 16 Nov 94	General Specifications for Cable Electrical, MIL–STD–1553, Data Bus, Space Quality
TIA/EIA–422 Rev B 13 April 1994	Electrical Characteristics of Balanced Voltage Digital Interface Circuits

3.0 GENERAL

3.1 ENGINEERING UNITS AND TOLERANCES

When identified, dimensions in this document are shown first in the English Inch Pound (IP) system, and then in the metric equivalent Systems International units (SI) shown in parenthesis. Conversion of units shall be in accordance with ASTM E380. Unless otherwise specified, all dimensions are in accordance with ANSI–Y–14.5.

SECTION A3 SSMB TO MRS BASE SYSTEM (MBS) INTERFACE

A3.0 REQUIREMENTS

A3.1 GENERAL

The MT will interface with the MBS. The MT provides the mobility function for the MBS. Space Station resources are transferred by the MT from the ITA to the MBS to enable it to perform assembly, servicing, transportation, and deployment functions.

The MBS provides the mechanical and electrical interface with the MT. Mechanical attachments provide a stiff base to transmit loads from the MBS through the MT to the truss. The electrical connections transfer power, data, and video across the MT and MBS interface. The MBS is also equipped with EVA power outlets to interface with EVA tools and lights.

A3.1.1 INTERFACE DESCRIPTION

The SSMB to MBS interfaces consist of structural, mechanical, thermal, environmental, power, data, and video interfaces.

A3.1.2 COORDINATE SYSTEMS

The Space Station integrated stage configurations and elements will be in accordance with the coordinate systems defined in SSP 30219, Space Station Reference Coordinate Systems.

A3.1.3 SSMB INTERFACE FUNCTIONS

The SSMB shall :

A. Provide and circuit protect power to the MBS

B. Control the power supply to the MBS

C. Provide a local data bus to the MBS interface

D. Provide video sync and control signals to the MBS

E. Receive video signals from the MBS

F. Receive power from the MBS EVA power outlets for the SSMB Tools

The MT shall :

G. Provide mechanical and structural attachments to the MBS (with passive alignment features)

H. Provide utility distribution to the MBS

I. Provide EVA access to interface attachments and connections

A3.1.4 MBS INTERFACE FUNCTIONS

The MBS shall :

A. Provide mechanical and structural attachment to the MT

B. Provide the active interfaces for MT interface alignment

C. Provide cable harnesses for utility distribution to the MT connector panel

D. Provide EVA access to interface attachments and connections

E. Provide viewing for MBS installation

F. Receive power from the SSMB

G. Receive a local bus from the SSMB

H. Receive video sync and control from the SSMB

I. Provide video to the SSMB

J. Provide two EVA power outlets

A3.1.5 INTERFACE RESPONSIBILITIES

The interface hardware responsibilities will be as defined in Table A3.1.5–1.

A3.2 INTERFACE REQUIREMENTS

A3.2.1 SSMB INTERFACE REQUIREMENTS

A3.2.1.1 MT HARDWARE ENVELOPES

a) The MT shall provide an EVA and installation envelope for mating the MBS, in accordance with SSP 50005, ISS Flight Crew Standard.

b) The MT shall provide attachment mechanisms in accordance with SSP 50005.

c) The MT shall provide EVA translation aids to enable EVA MBS integration in accordance with SSP 30256:001, EVA Standard ICD.

A3.2.1.2 MT MECHANICAL INTERFACES

a) The MT shall provide 4 bolt holes for the MBS.

b) The MT shall provide a capture bar and alignment features to mate the MBS.

c) The MT nuts shall be capable of being engaged/disengaged via EVA using standard EVA tools .

d) The torque required to engage and disengage the attachments bolts shall not exceed 25 ft–lbs (33.89 N–m).

e) The MT shall support a minimum preload of 2000 lbs applied to each of the attachment bolts.

f) The MT shall provide 4 nuts each equipped with a contingency release mechanism for the on orbit removal of the primary MBS/MT interface nut/bolt sets via EVA in the event of a bolt jam.

g) The torque required to remove these nuts by contingency shall not exceed 25 ft–lbs (33.89 N–m).

A3.2.1.2.1 MT ALIGNMENT TOLERANCE

The MT error (while stationary) from its nominal position with respect to the SS truss reference coordinate axis, at the MBS/MT interface including errors due to MT latching to the SS truss, thermal distortions, and ORU changeout shall not exceed the values defined in Table A3.2.1.2.1–1.

A3.2.1.3 MT STRUCTURAL INTERFACES

A3.2.1.3.1 MT STIFFNESS REQUIREMENTS

A3.2.1.3.1.1 MT STATIONARY STIFFNESS REQUIREMENTS

The minimum stiffness requirement of the MT during stationary operations at the MBS interface shall be as defined in Table A3.2.1.3.1.1–1.

A3.2.1.3.1.2 MT STIFFNESS REQUIREMENTS DURING TRANSLATION

The minimum stiffness requirement of the MT during translation shall be as defined in Table A3.2.1.3.1.2–1. The stiffness requirements should be satisfied for the following forces and moments: $-180 < F_x < +625$ lbf, $-26 < F_y < +26$ lbf, $-65 < F_z < +75$ lbf; $-2{,}250 < M_x < +2{,}100$ in–lbf, $-6{,}100 < M_y < +7{,}000$ in–lbf, $-3{,}300$ in–lbf $< M_z < +2{,}600$ in–lbf; when each component is applied individually to the MT at geometric center of MT/MBS interface.

A3.2.1.3.2 MT LOADS REQUIREMENTS

a) Stationary Loads:

The MT structure when latched at a worksite shall withstand the worst of the following three independent load cases:

i) $Fx = \pm 3{,}800$ lbf & $My = \pm 146{,}400$ in–lbf
ii) $Fy = \pm 3{,}800$ lbf & $Mz = \pm 146{,}400$ in–lbf & $Mx = \pm 108{,}000$ in–lbf
iii) $Fz = \pm 3{,}800$ lbf & $Mx = \pm 108{,}000$ in–lbf

b) The MT/MBS interface load spectrum for 15 years life when secured at a worksite shall be as defined below:

Amplitude Tier (%)	Cycle Count
90–100	15
80–90	0
70–80	2
60–70	7
50–60	32
40–50	75
30–40	156,751
20–30	770,260
15–20	361,056
10–15	1,343,024
5–10	3,313,571
2.5–5	2,801,441

There should be no gapping for moments up to 67,250 in–lbf applied in any direction to MT/MBS interface.

c) MT/MBS guide pins and guide pin receptacles shall be designed for local MT to MBS berthing limit loads of $\pm$ 1065 lbf shear and 1650 lbf axial force per guide pin/receptacle.

d) MT/MBS capture bar and capture latch shall be designed for local MT to MBS berthing limit loads of $\pm$ 233 lbf shear in Y direction and $\pm$ 526 lbf shear in Z direction and 539 lbf axial force.

e) MT/MBS corner berthing features shall be designed for local MT to MBS berthing limit loads of 3773 lbf axial force per corner bolt/receptacle.

f) Translational Loads:

During MT translation, MT structure shall withstand the limit loads defined by interaction equations A3.2.1.3.2–1 through 4. The uni–directional limit loads, which are referenced by the below interaction equations, are defined in Table A3.2.1.3.2–1 and represent the maximum loads generated by on–orbit loading environments excluding MT events (loads are applied to the MT at the geometric center of MT/MBS interface).

Equation A3.2.1.3.2–1

$$\frac{F_y^{\pm}}{F_{yu}^{\pm}} \leq 1$$

Equation A3.2.1.3.2–2

$$-1 \leq -\mathrm{SIGN}(F_x)\frac{F_x^{\pm}}{F_{xu}^{\pm}} + \mathrm{SIGN}(M_y)\frac{M_y^{\pm} - F_z \cdot h}{M_{yu}^{\pm}} \leq 1$$

Equation A3.2.1.3.2–3

$$-1 \leq -\mathrm{SIGN}(F_x)\frac{F_x^{\pm}}{F_{xu}^{\pm}} - \mathrm{SIGN}(M_y)\frac{M_y^{\pm} + F_z \,.\, h}{M_{yu}^{\pm}} + \frac{M_z^{\pm} + F_y \,.\, h}{M_{zu}^{\pm}} \leq 1$$

Equation A3.2.1.3.2–4

$$-1 \leq \frac{F_z^{\pm}}{F_{zu}^{\pm}} + \frac{M_x^{\pm} - F_y \,.\, w}{M_{xu}^{\pm}} \leq 1$$

Where,

F_i & M_i ; i=x,y,z — are the time consistent interface loads at MT/MBS interface applied to MT at the geometric center of that interface

F_{iu} & M_{iu} ; i=x,y,z — are the uni–directional structural limit loads at MT/MBS interface applied to MT at the geometric center of that interface, see Table A3.2.1.3.2–1.

superscript $^{\pm}$ — indicates the direction of load, all numerator/denominator pairs should have same signs

h = 30.58”

w = 32.70”

SIGN (x) = –1 for x < 0

SIGN (x) = 1 for x > 0

g) The MT/MBS interface load spectrum during translation due to on–orbit loading environments excluding MT events shall be 30,000 cycles at the most critical loading conditions defined by item f.

h) MT structure shall withstand loads generated by MT events which include segment to segment gap crossing, SARJ gap crossing, braking, and impact to ESU. MT/MBS loads due to MT events are enveloped by the following two cases:

i) A maximum 37 lbf force vector in XZ plane, or

ii) The resulting load due to instantaneous application of a 150 lbf braking force along Y direction at MT to ITA interface applied at x= –30.33, y= $\pm$6.13, and z= –32.70 inch relative to the geometric center of MT to MBS interface. The maximum kinetic energy in this case will be 717 in–lbf which corresponds to 3.1 in/sec velocity for MT with its maximum design payload.

A3.2.1.3.3 MT CAPTURE BAR LOAD REQUIREMENTS

a) After MBS berthing capture and application of the berthing mechanism preload, the on–orbit forces due to ISS operation applied to the MBS shall not result in a moment about the capture latch mechanism in excess of 18,000 in–lbs until after the four MBS/MT mating bolts are completely installed.

b) After the installation of these MBS/MT interface bolts, the MBS/MT interface on–orbit loads requirements of paragraph A3.2.1.3.2 shall apply.

A3.2.1.4 MT ELECTRICAL INTERFACE HARDWARE

The MT shall provide fixed connectors for the MBS umbilicals to be mated by EVA.

A3.2.1.4.1 ELECTRICAL CONNECTORS

The MT electrical connectors at the interface shall comply with the requirements of SSQ 21635, General Specifications for Connectors and Accessories, Electrical, Circular, Miniature, IVA/EVA/Robot Compatible, Space Quality.

A3.2.1.5 SSMB MT TO MBS ELECTRICAL INTERFACES

The SSMB MT to MBS electrical interfaces shall be as shown in Figure A3.2.1.5–1.

Power, data and video resources are not available to the MBS during MT translation.

A3.2.1.5.1 SUPPLY POWER

The SSMB MT shall supply power to the MBS through the MSCUTILITYA and MSCUTILITYB power circuits.

A3.2.1.5.1.1 POWER QUALITY

The interface power quality shall be in accordance with SSP 30482, Volumes I and II, Interface B, with a steady state voltage range defined in Table A3.2.1.5–1.

A3.2.1.5.1.2 FAULT PROTECTION

The SSMB shall provide protection as shown in Table A3.2.1.5–1.

A3.2.1.5.2 DELETED

A3.2.1.5.3 DELETED

A3.2.1.5.4 ELECTRICAL CONNECTOR DEADFACING

The SSMB shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

A3.2.1.5.5 SHIELDING

The MT shields shall be terminated to structure or chassis at each end.

A3.2.1.5.6 REDUNDANCY

a) The MT shall provide a prime and redundant power feed to the MBS.

b) Each of the power feeds shall have the capability to supply power to the MBS as defined in Table A3.2.1.5–1.

c) The SSMB shall provide the capability to simultaneously provide power on both of these feeds.

A3.2.1.6 C&DH INTERFACES

a) The MT shall provide the A channel of the MSS local bus (MSS LB) stub and the B channel of the MSS local bus (MSS LB) stub through separate connectors.

b) The SSMB shall provide an extension of the MSS LB to the MBS as shown in Figure A3.2.1.6–1.

A3.2.1.6.1 PROVIDE OUTPUT AMPLITUDE

SSMB shall provide a signal amplitude of at least 17 volts, peak–to–peak, line–to–line, at the MBS interfaces for messages transmitted on the MIL–STD–1553 bus.

A3.2.1.6.2 MIL–STD–1553 DATA BUS ADDRESSES

The MIL–STD–1553 Bus Addresses for the SSMB Remote Terminals (RTs) on the MSS Local Bus (MSS LB) shall be as defined in Table A3.2.1.6.2–1.

A3.2.1.7 SSMB SYNC, CONTROL, AND VIDEO INTERFACES

a) The SSMB shall provide sync, control, and video interfaces to the MBS as shown in Figure A3.2.1.5–1.

b) The MT shall provide two sets of interfaces, each containing three video and two sync copper lines to distribute Pulse Frequency Modulated (PFM) sync and control and to receive PFM video from the MBS.

c) The SSMB shall route one video channel from each set of interfaces to each VSW(E).

d) The MT shall be a pass–through for video.

e) One sync and control signal and two simultaneous video views shall be available after the first video system failure.

f) The sync and control signal transmitted across the interface shall include the camera commands multiplexed on the signal.

A3.2.1.7.1 SSMB VIDEO, SYNC, AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS

a) The SSMB shall transmit PFM sync and control signals and receive PFM video signals from the MBS in accordance with TBD.

b) The SSMB PFM video and PFM sync signal power levels at the MBS/MT interface shall be as defined in Table A3.2.1.7.1–1.

A3.2.1.7.2 DELETED

A3.2.1.8 MT THERMAL INTERFACES

The MT shall provide compliance at the interface to ensure that the 4 nuts can align with the four 1/2” (fixed) bolts when the MT and MBS have a temperature difference of not greater than 27.7 degrees Celsius (50 degrees Fahrenheit).

A3.2.1.9 ENVIRONMENTS

A3.2.1.9.1 ELECTROMAGNETIC EFFECTS

A3.2.1.9.1.1 ELECTROMAGNETIC COMPATIBILITY

The SSMB interface with the MBS shall meet the requirements of SSP 30243, Space Station Systems Requirements for Electromagnetic Compatibility.

A3.2.1.9.1.2 GROUNDING

The MT interface shall meet the requirements of SSP 30240, Space Station Grounding Requirements.

A3.2.1.9.1.3 BONDING

a) The MT structural/mechanical interface shall meet the requirements of SSP 30245, Space Station Electrical Bonding Requirements.

b) The MT shall provide a Class H and R bond in accordance with the above referenced document.

A3.2.1.9.1.4 CABLE AND WIRE DESIGN

The MT cable and wire interface shall meet the requirements of SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility.

A3.2.1.9.1.5 ELECTROSTATIC DISCHARGE

The MT interface shall meet the requirements of SSP 30243.

A3.2.1.9.1.6 CORONA

The MT interface shall meet the requirements of SSP 30243.

A3.2.2 MBS INTERFACE REQUIREMENTS

A3.2.2.1 MBS HARDWARE ENVELOPE

a) The MBS shall provide an EVA and installation envelope for mating to the MT.

b) The MBS shall provide attachment mechanisms in accordance with SSP 50005 for accessibility by EVA crew members.

c) The MBS shall provide EVA translation aids in accordance with SSP 30256:001, EVA Standard Interface Control Document to enable EVA MBS integration and translation between elements.

A3.2.2.2 MBS MECHANICAL INTERFACES

a) The MBS shall provide four 1/2” EVA compatible bolts to mate with the MT.

b) The MBS shall provide alignment guides and a capture latch to interface with the MT guide pins and capture bar.

c) The MBS attachment bolts shall be capable of being engaged/disengaged via EVA using standard EVA tools.

d) The torque required to engage and disengage the attachments bolts shall not exceed 25 ft–lbs (33.89 N–m).

e) The MBS shall support a minimum preload of 2000 lbs applied to each of the attachment bolts.

f) The MT Capture Latch (MTCL) on the MBS shall support a preload (with latch closed) between 800 lbs and 1850 lbs.

g) The MBS shall provide the MT/MBS interface umbilicals and the MBS ORU connectors to mate the electrical utilities to the MT.

A3.2.2.3 MBS STRUCTURAL INTERFACES

A3.2.2.3.1 DELETED

A3.2.2.3.2 MBS LOADS REQUIREMENTS

a) Stationary Loads:

The MBS structure when MT is latched at a worksite shall withstand the worst of the following three independent load cases applied to the MT/MBS interface:

a) Fx = ± 3,800 lbf & My = ± 146,400 in–lbf
b) Fy = ± 3,800 lbf & Mz = ± 146,400 in–lbf & Mx = ± 108,000 in–lbf
c) Fz = ± 3,800 lbf & Mx = ± 108,000 in–lbf

b) The MT/MBS interface load spectrum for 15 years life when secured at a worksite shall be as defined below:

Amplitude Tier (%)	Cycle Count
90–100	15
80–90	0
70–80	2
60–70	7
50–60	32
40–50	75
30–40	156,751
20–30	770,260
15–20	361,056
10–15	1,343,024
5–10	3,313,571
2.5–5	2,801,441

There should be no gapping for moments up to 67,250 in–lbf applied in any direction to MT/MBS interface.

c) MT/MBS guide pins and guide pin receptacles shall be designed for local MT to MBS berthing limit loads of ± 1065 lbf shear and 1650 lbf axial force per guide pin/receptacle.

d) MT/MBS capture bar and capture latch shall be designed for local MT to MBS berthing limit loads of ± 233 lbf shear in Y direction and ± 526 lbf shear in Z direction and 539 lbf axial force.

e) MT/MBS corner berthing features shall be designed for local MT to MBS berthing limit loads of 3773 lbf axial force per corner bolt/receptacle.

f) Translational Loads :

During MT translation, MBS structure shall withstand the limit loads defined by interaction equations A3.2.1.3.2–1 through 4. The uni–directional limit loads, which are referenced by the above interaction equations, are defined in Table A3.2.1.3.2–1 and represent the maximum loads generated by on–orbit loading environments excluding MT events (loads are applied to the MT at the geometric center of MT/MBS interface).

g) The MT/MBS interface load spectrum during translation due to on–orbit loading environments excluding MT events shall be 30,000 cycles at the most critical loading conditions defined by item f.

h) MBS structure shall withstand loads generated by MT events which include segment to segment GAP crossing, SARJ gap crossing, braking, and impact to ESU. MT/MBS loads due to MT events are enveloped by the following two cases:

i) A maximum 37 lbf force vector in XZ plane, or

ii) The resulting load due to instantaneous application of a 150 lbf braking force along Y direction at MT to ITA interface applied at x= –30.33, y= ± 6.13, and z= –32.70 inch relative to the geometric center of MT to MBS interface. The maximum kinetic energy in this case will be 717 in–lbf which corresponds to a 3.1 in/sec velocity for MT with its maximum design payload.

A3.2.2.3.3 MTCL LOAD REQUIREMENTS

a) After MBS berthing capture and application of the berthing mechanism preload, the on–orbit forces due to ISS operation applied to the MBS shall not result in a moment about the capture latch mechanism in excess of 18,000 in–lbs until after the four MBS/MT mating bolts are completely installed.

b) After the installation of these MBS/MT interface bolts, the MBS/MT interface on–orbit loads requirements of paragraph A3.2.1.3.2 shall apply.

A3.2.2.4 MBS ELECTRICAL INTERFACE HARDWARE

The MBS electrical connectors at the interface shall comply with the requirements of SSQ 21635.

A3.2.2.5 SSMB MT TO MBS ELECTRICAL INTERFACES

a) The SSMB MT to MBS electrical interfaces shall be as shown in Figure A3.2.1.5–1. Power, data and video resources are not available to the MBS during MT translation.

b) The MBS shall provide two EVA power outlets.

A3.2.2.5.1 RECEIVE POWER

The MBS shall provide the capability to receive power through the MSCUTILITYA and MSCUTILITYB power circuits.

A3.2.2.5.1.1 POWER QUALITY

The interface power quality shall be in accordance with SSP 30482, Volumes I and II, Interface B, with a steady state voltage range as defined in Table A3.2.1.5–1.

A3.2.2.5.2 DELETED

A3.2.2.5.3 ELECTRICAL CONNECTOR DEADFACING

The MBS shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

A3.2.2.5.4 SHIELDING

The MBS shields shall be terminated to structure or chassis at each end.

A3.2.2.5.5 REDUNDANCY

a) The MBS shall receive a prime and redundant power feed from the MT.

b) The MBS shall receive power in accordance with Table A3.2.1.5–1.

A3.2.2.6 C&DH INTERFACES

a) The MBS shall receive the A channel of the MSS local bus (MSS LB) stub and the B channel of the MSS local bus (MSS LB) stub through separate connectors.

b) The MBS shall receive an extension of the MSS LB from the MT as shown in Figure A3.2.1.6–1.

A3.2.2.6.1 PROVIDE OUTPUT AMPLITUDE

MBS shall provide a signal amplitude of at least 2.35 volts, peak–to–peak, line–to–line, at the SSMB interfaces for messages transmitted on the MIL–STD–1553 bus.

A3.2.2.6.2 MIL–STD–1553 DATA BUS ADDRESSES

The MIL–STD–1553 bus addresses for the MSS RTs on the MSS Local Bus shall be as defined in Table A3.2.1.6.2–1.

A3.2.2.7 MBS SYNC, CONTROL, AND VIDEO INTERFACES

a) The MBS shall provide sync, control, and video interfaces to the MT as shown in Figure A3.2.1.5–1.

b) The MBS shall receive two sets of interfaces, each containing three video and two sync copper lines to distribute PFM sync and control and to provide PFM video to the MT.

c) The MBS video transmitted across the interface shall include the camera telemetry multiplexed on the video signal.

d) One sync and control signal and two simultaneous video views shall be available after the first video system failure.

A3.2.2.7.1 MBS VIDEO, SYNC, AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS

a) The MBS shall transmit PFM video signals and receive PFM sync and control signals in accordance with TBD.

b) The MBS PFM video and PFM sync signal power levels at the MBS/MT interface shall be as defined in Table A3.2.2.7.1–1.

A3.2.2.7.2 DELETED

A3.2.2.8 MBS THERMAL INTERFACES

The MBS shall support a temperature difference of not greater than 27.7 degrees Celsius (50 degrees Fahrenheit) at the interface to ensure that the 4 nuts can align with the four 1/2" (fixed) bolts.

A3.2.2.9 ENVIRONMENTS

A3.2.2.9.1 ELECTROMAGNETIC EFFECTS

A3.2.2.9.1.1 ELECTROMAGNETIC COMPATIBILITY

The MBS interface with the SSMB shall meet the requirements of SSP 30243, Space Station Systems Requirements for Electromagnetic Compatibility.

A3.2.2.9.1.2 GROUNDING

The MBS interface shall meet the requirements of SSP 30240, Space Station Grounding Requirements.

A3.2.2.9.1.3 BONDING

a) The MBS structural/mechanical interface shall meet the requirements of SSP 30245, Space Station Electrical Bonding Requirements.

b) The MBS shall provide a Class H and R bond in accordance with the above referenced document.

A3.2.2.9.1.4 CABLE AND WIRE DESIGN

The MBS cable and wire interface shall meet the requirements of SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility.

A3.2.2.9.1.5 ELECTROSTATIC DISCHARGE

The MBS interface shall meet the requirements of SSP 30243.

A3.2.2.9.1.6 CORONA

The MBS interface shall meet the requirements of SSP 30243.

TABLE A3.1.5–1 MT TO MBS INTERFACE HARDWARE RESPONSIBILITIES

MT/MBS INTERFACE	NASA	CSA
– MT Nut (including bolt locking features)	X	
– MT Fine Alignment Features	X	
– MT Coarse Alignment Pins	X	
– MT Connector Panel	X	
– MT Capture Bar	X	
– MBS EVA Bolts (4)		X
– MBS Coarse Alignment V–Guides		X
– MBS Fine Alignment Features		X
– MBS Power, Data, Video Harnesses		X
– MBS MT Capture Latch (MTCL)		X
– MBS Power Outlets		X

TABLE A3.2.1.2.1–1 MT STATIONARY ALIGNMENT TOLERANCE

Direction	Axial	Rotational
X and Y axis	±0.25” (6.35 mm)	± 0.1 deg.
Z axis	±0.13” (3.30 mm)	± 0.1 deg.

Note: The manufacturing and assembly error of the MT and the interface hardware will be measured on the ground prior to launch. This error will be recorded in the MT and the MRS data base as a fixed error that will be compensated for in positioning the SSRMS or the SPDM.

TABLE A3.2.1.3.1.1–1 MT STATIONARY STIFFNESS REQUIREMENTS

Direction	Minimum Stiffness	Free Play
Axial X, Y and Z axis	2000 lbs/in (350,400 N/m)	0.0
Rotational X, Y and Z axis	26,000,000 in–lbs/rad (2,940,000 Nm/rad)	0.0

TABLE A3.2.1.3.1.2–1 MT TRANSLATION STIFFNESS REQUIREMENTS

Direction	Minimum Stiffness	Free Play
Translational X and Z axis	1000 lbs/in (175,126 N/m)	0.0
Translational Y axis	450 lbs/in (78,806 N/m)	0.0
Rotational X axis	15,000,000 in–lbs/rad (1,690,000 Nm/rad)	0.0
Rotational Y and Z axis	17,500,000 in–lbs/rad (1,980,000 Nm/rad)	0.0

TABLE A3.2.1.3.2–1 MT/MBS ON–ORBIT UNI–DIRECTIONAL STRUCTURAL LIMIT LOADS DURING TRANSLATION

COMPONENT	MAX–NEGATIVE	MAX–POSITIVE
^{F} xu(lbf)	–180	625
^{F} yu(lbf)	–26	26
^{F} zu(lbf)	–65	75
^{M} xu(in–lbf)	–2,250	2,100
^{M} yu(in–lbf)	–6,100	7,000
^{M} zu(in–lbf)	–3,300	2,600

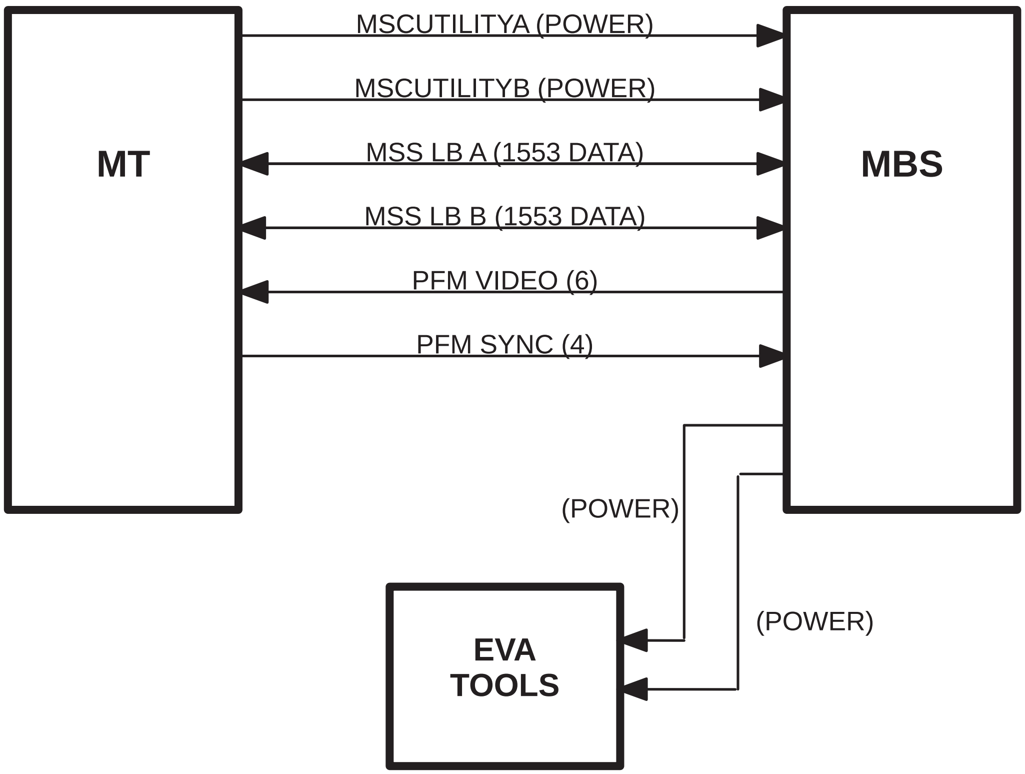


FIGURE A3.2.1.5–1 MT TO MBS ELECTRICAL INTERFACES

TABLE A3.2.1.5–1 ELECTRICAL INTERFACE PARAMETERS

Circuit Name	INTERFACE V_{range} (volts)	Operating Current (amps)	Overcurrent Protection
MSCUTILITYA (Final)	115 to 126 (Note 4) or 118 to 126 (Note 5)	0 to 50 (Notes 3,4) or 0 to 48.3 (Notes 3,5)	Notes 1,2
MSCUTILITYB (Final)	115 to 126 (Note 4) or 118 to 126 (Note 5)	0 to 50 (Notes 3,4) or 0 to 48.3 (Notes 3,5)	Notes 1,2
MSCUTILITYA (Interim) (Note 6)	115 to 126 (Note 4)	0 to 25 (Notes 3,4)	Notes 1,2
MSCUTILITYB (Interim) (Note 6)	115 to 126 (Note 4)	0 to 25 (Notes 3,4)	Notes 1,2

Notes 1 Protection is equivalent with SSP30263:002, Type IV RPCM Standard ICD.

2 Current limiting is equivalent with SSP30263:001, DDCUE Standard ICD.

3 DDCU is thermally limited to provide 52 amps on a continuous basis; exceeding 52 amps may result in DDCU shutdown.

4 Circuits will receive this interface voltage and operating current when MT is located on the truss segments inboard of the Solar Alpha Rotary Joint (SARJ) (i.e. S0, S1, S3, P1, P3)

5 Circuits will receive this interface voltage and operating current when MT is located on the truss segments outboard of the SARJ (i.e. S4, S6, P4, P6)

6 Interim power is during flights 8A through 12A

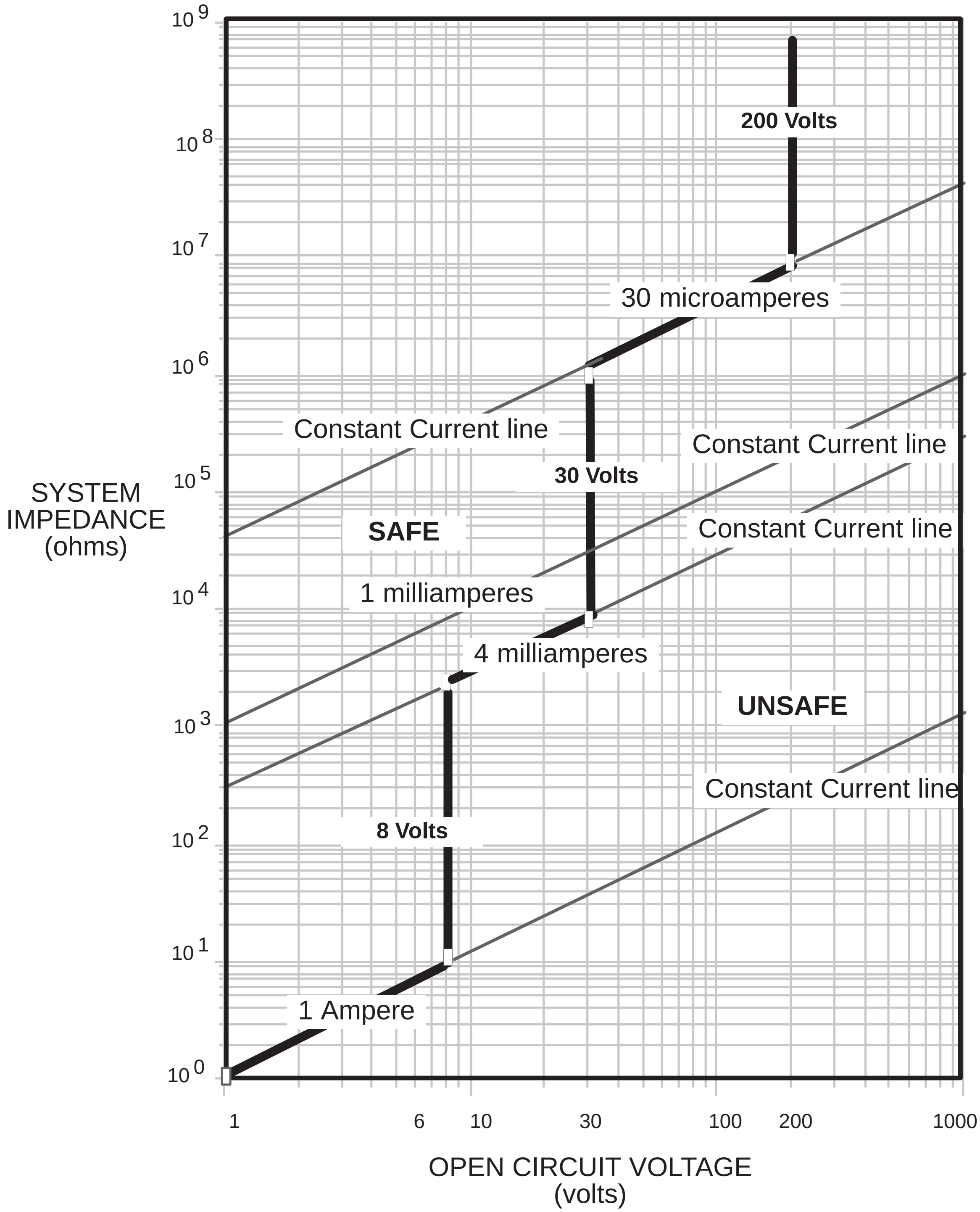
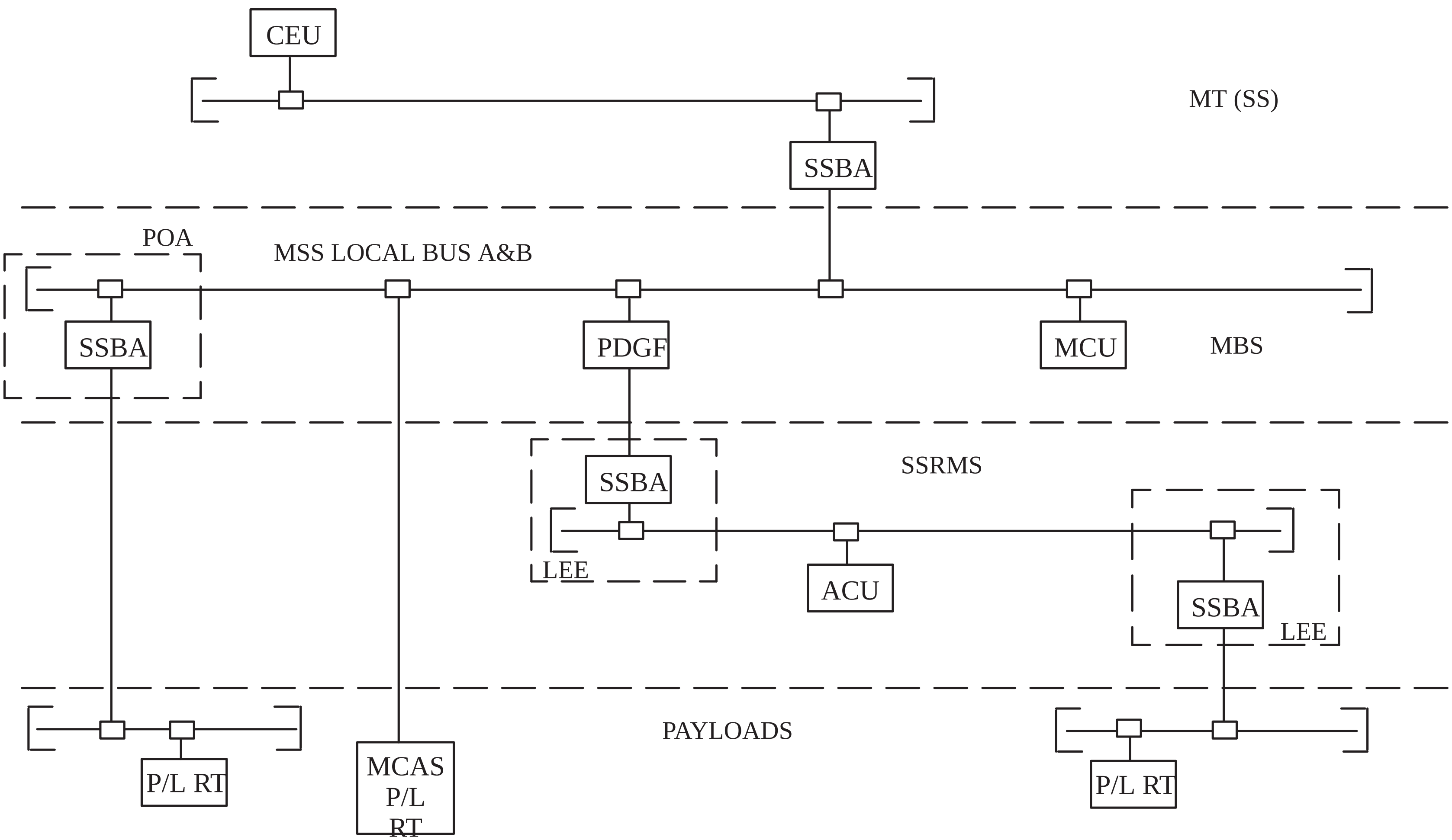


FIGURE A3.2.1.5.4–1 CONNECTOR DEADFACING REQUIREMENTS



Legend

SSBA: SS Buffer Amplifier
□ Bus Coupler
[Bus Termination
MCU: MBS Control Unit
ACU: SSRMS Arm Control Unit
CEU: Control Electronics Unit

FIGURE A3.2.1.6–1 MSS LB CONFIGURATION

TABLE A3.2.1.6.2–1 MSS LB ADDRESSES (PAGE 1 OF 2)

Bus:	**MSS LB**		
Figure Reference	Long Name	Address	Location
None	Not used	0	None
None	Reserved (SPDM BDU Default address)	1	None
None	Payload RT (generic)	2	Note 2
None	Not used	3	None
None	Payload RT (generic)	4	Note 2
RWS CEU–2	Robotics Workstation Control Electronics Unit #2	5	USL
SPDM PSU	SPDM Power Switching Unit	6	SPDM
None	Payload RT (generic)	7	Note 2
None	Not used	8	None
None	Not used	9	None
None	Not used	10	None
None	Not used	11	None
RWS CEU–1	Robotics Workstation Control Electronics Unit #1	12	USL
None	Not used	13	None
ACU–R IOC	Arm Control Unit–R Input/Output Card	14	SSRMS
ACU–R Safing RT	Arm Control Unit–R Safing RT	15	SSRMS
SPDM BDU	SPDM Backup Drive Unit	16	SPDM
ACU1 Safing RT	SPDM ACU1 Safing RT	17	SPDM
ACU1 IOC	SPDM ACU1 Input/Output Card	18	SPDM
SCU #2 Safing RT	SPDM ACU2 Safing RT	19	SPDM
SCU #2 IOC	SPDM ACU2 Input/Output Card	20	SPDM
None	Payload RT (MCAS)	21	Note 2
MCU–R IOC	MBS Control Unit–R Input/Output Card	22	MBS
MCU–R Safing RT	MBS Control Unit–R Safing RT	23	MBS
None	Not used	24	None
None	Not used	25	None
MCU IOC	MBS Control Unit Input/Output Card	26	MBS
MCU Safing RT	MBS Control Unit Safing RT	27	MBS

TABLE A3.2.1.6.2–1 MSS LB ADDRESSES (PAGE 2 OF 2)

Bus:	MSS LB		
None	Not used	28	None
ACU Safing RT	Arm Control Unit Safing RT	29	SSRMS
ACU IOC	Arm Control Unit Input/Output Card	30	SSRMS
None	Reserved (1553B Broadcast Address)	31	None
Notes:			
1) MBS is located on the MSS local bus after installation. 2) MCAS payloads must use address 21. All other payloads can use any of the payload RT addresses including 21 if an MCAS payload is not present.			

TABLE A.3.2.1.7.1–1 SSMB SYNC AND VIDEO POWER LEVELS

PARAMETER	MINIMUM	MAXIMUM
Video output from MBS to MT input	+3.6 dBm	+9 dBm
Sync output from MT to MBS input	–10.6 dBm	+9dBm
Return Loss (Absolute)	16 dB	N/A
Group Delay (TUS Cable)	N/A	5 nsecs
Group Delay Slope (TUS Cable)	N/A	0.4 nsecs/MHz
Isolation	50 dB	N/A

TABLE A.3.2.2.7.1–1 MBS SYNC AND VIDEO POWER LEVELS

PARAMETER	MINIMUM	MAXIMUM
Video output from MBS to MT input	+3.6 dBm	+9 dBm
Sync input to MBS from MT	–10.6 dBm	+9dBm
Return Loss (Absolute)	16 dB	N/A

Note: 1) For the MBS, all measurements are performed at the end of the jumper cable interfacing the MBS to the MT

SECTION B3 DELETED

B3.0 DELETED

SECTION C3 USL TO AVU INTERFACE

C3.0 REQUIREMENTS

C3.1 GENERAL

C3.1.1 INTERFACE DESCRIPTION

The USL interface provides structural, mechanical, thermal, environmental, power, data, and video interfaces for the AVU.

C3.1.2 COORDINATE SYSTEMS

The Space Station integrated stage configurations and elements will be in accordance with the coordinate systems defined in SSP 30219, Space Station Reference Coordinate Systems.

C3.1.3 USL INTERFACE FUNCTIONS

The USL interface shall :

A. Provide mechanical and structural attachments to the AVU
B. Provide utility distribution to the AVU
C. Provide utility distribution between the AVU and the RWS
D. Provide overcurrent protected 120 VDC power to the AVU
E. Control the 120 VDC power supply to the AVU
F. Provide data to and receive data from the AVU
G. Provide video, sync and control to the AVU
H. Receive video from the AVU
I. Provide an envelope for the AVU
J. Provide thermal control to the AVU via baseplate cooling
K. Provide data distribution between the AVU and the AVU cursor control device (CCD).

C3.1.4 AVU INTERFACE FUNCTIONS

The AVU shall :

A. Provide mechanical and structural attachment to the USL interface
B. Provide connectors to support utility distribution with the USL interface
C. Receive power from the USL interface
D. Provide data to and receive data from the USL interface
F. Receive video, sync and control from the USL interface
G. Provide video to the USL interface
H. Receive thermal conditioning from the USL
I. Provide connector to support data distribution to the AVU CCD

C3.1.5 INTERFACE RESPONSIBILITIES

The interface hardware responsibilities will be as defined in Table C3.1.5–1.

C3.2 INTERFACE REQUIREMENTS

C3.2.1 USL INTERFACE REQUIREMENTS

C3.2.1.1 USL HARDWARE ENVELOPES

The USL shall contain two equipment rack locations for the AVU. The USL shall support the AVU envelopes as defined in Figure C3.2.1.1–1 and C3.2.1.1–2.

C3.2.1.2 USL MECHANICAL INTERFACES

The USL shall provide mechanical interfaces for the AVU as defined in SSP 30258:006; Section 3.4.1, ORU to Coldplate Installation and Section 3.4.3, Surface Finish. The USL shall provide coldplate interfaces to the AVU as defined in SSP 30258:006, Figure B–8 (Boeing Part Number 683–10041–8). The USL Rack fasteners shall interface to AVU threaded inserts as defined in Figure 3.2.2.2–1 (actual fastener usage may be reduced if thermal transfer and structural adequacy is insured).

C3.2.1.3 USL STRUCTURAL INTERFACES

The single point fastener maximum limit load for combined high and low frequency load case are shown below

Axial (lbs)	Shear (lbs)
367	212

C3.2.1.4 ELECTRICAL CONNECTORS

The USL electrical connectors at the interface shall comply with the requirements of SSQ 21635, General Specifications for Connectors and Accessories, Electrical, Circular, Miniature, IVA/EVA/Robot Compatible, Space Quality.

C3.2.1.5 POWER INTERFACES

The USL to AVU power interfaces shall be as shown in Figure C3.2.1.5–1.

C3.2.1.5.1 SUPPLY POWER

The USL shall supply power to the primary AVU (LAS5) through the AVU2 power circuits. The USL shall supply power to the secondary AVU (LAP5) through the AVU1 power circuit.

C3.2.1.5.1.1 POWER QUALITY

Power quality shall be in compliance with “interface C” as defined in SSP 30482, Volume I.

C3.2.1.5.1.2 FAULT PROTECTION

The USL shall provide protection as shown in Table C3.2.1.5–1.

C3.2.1.5.2 GROUNDING

The USL grounding interface shall meet the requirements of SSP 30240, SSP Grounding Requirements.

C3.2.1.5.3 BONDING

The USL structural/mechanical interface shall meet the requirements of SSP 30245, SSP Electrical Bonding Requirements. The USL shall satisfy a Class R bond in accordance with the above reference document.

The bonding path will be through the coldplate. Each AVU will be electrically bonded to the supporting structure by metal–to–metal contact.

C3.2.1.5.4 SHIELDING

The USL shields shall be terminated to structure, chassis or connector backshell at each end.

C3.2.1.5.5 ELECTRICAL CONNECTOR DEADFACING

The USL shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

C3.2.1.5.6 DELETED

C3.2.1.5.7 DELETED

C3.2.1.6 C&DH INTERFACES

The RWS (CEU) will communicate as a bus controller in accordance with SSP 50098, paragraph 3.2.2.6.1.3, with the AVU interface characteristics as specified in MIL–STD–1553B. The USL shall provide a PDGF local bus stub connection to the AVU as shown in Figure C3.2.1.5–1.

C3.2.1.6.1 AVU CURSOR CONTROL DEVICE (CCD) DATA INTERFACE

The USL shall support the distribution of a uni–directional TIA/EIA–422 interface from the D&C panel to the AVU for the AVU Cursor Control Device. The USL design at the TIA/EIA–422 interface shall be in accordance with paragraph C3.2.1.4 and SSQ 21655, Section 3.0, Requirements.

C3.2.1.6.2 MIL–STD–1553 INTERFACES

C3.2.1.6.2.1 RESPOND TO INPUT SIGNAL AMPLITUDE

When receiving addressed messages with MIL–STD–1553 defined waveforms at the AVU interface, the CEU will provide response message in MIL–STD–1553 format.

C3.2.1.6.2.2 PROVIDE OUTPUT SIGNAL AMPLITUDE

The CEU will provide a signal amplitude of a minimum of 2.35 volts, peak–to–peak, line–to–line, at the AVU interfaces for AVU initiated messages transmitted on MIL–STD–1553 busses.

C3.2.1.6.2.3 BUS STUB LENGTH

The USL shall have a maximum bus stub length of 18 feet as measured from the coupling transformer to the USL/AVU interface as defined in Figure C3.2.1.6.2.3–1.

C3.2.1.6.2.4 MIL–STD–1553 DATA BUS ADDRESSES

The USL wiring harness shall provide up to 6 shorting links at the AVU data bus connector to define the five bit AVU RT address and a parity bit. A short circuit shall represent a logic zero, and odd parity shall be maintained. The MIL–STD–1553 bus addresses for the AVU RT at the AVU to USL interface shall be 11 for the Primary AVU (LAS5) and 8 for the Secondary AVU (LAP5).

C3.2.1.6.3 DELETED

C3.2.1.6.4 DELETED

C3.2.1.6.5 DELETED

C3.2.1.6.6 DELETED

C3.2.1.7 SYNC, CONTROL, AND VIDEO INTERFACES

The USL shall provide sync, control, and video interfaces to the AVU, as shown in Figure C3.2.1.5–1. The USL shall provide each AVU with one differential baseband sync signal and two differential baseband video input signals. The USL shall receive from each AVU, four differential baseband video output signals. The USL shall provide the capability to route the AVU video inputs to the CEU when the AVU is removed from the USL interface.

C3.2.1.7.1 VIDEO SYNC AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS

The USL shall supply differential baseband video and differential baseband sync and control signals to the AVU in accordance with EIA–RS–170A and the exceptions as specified in SSP

50002, paragraphs 3.2.1.1.5, and 3.2.1.4.2. The USL shall receive differential baseband video signals in accordance with SSP 50002, paragraph 3.2.1.4.2.

C3.2.1.8 THERMAL CONTROL SYSTEM INTERFACE CHARACTERISTICS

The USL shall provide 683–10041 –8 coldplate interfaces to the AVU as defined in SSP 30258:006, Internal TCS Coldplate Set Interface.

C3.2.1.9 ENVIRONMENTAL INTERFACES

Not Applicable

C3.2.1.10 SOFTWARE INTERFACES

The RWS CEU software interfaces to the AVU will be as specified in CSA–SS–ID–0002, MRCS to AVU ICD.

C3.2.2 AVU INTERFACE REQUIREMENTS

C3.2.2.1 AVU HARDWARE ENVELOPES

The AVU envelope shall be as defined in Figures C3.2.1.1–1 and C3.2.1.1–2.

C3.2.2.2 AVU MECHANICAL INTERFACES

The AVU shall provide mechanical interfaces to the USL as defined in SSP 30258:006; Section 3.4.1, ORU to Coldplate Installation (Paragraph 3.4.1.1.4; Structural Load Distribution is not applicable). The AVU shall provide a mounting configuration and threaded inserts as defined in Figure 3.2.2.2–1 for installation via USL Rack fasteners onto the USL (Boeing Part Number 683–10041–8) Coldplate (actual fastener usage may be reduced if thermal transfer and structure adequacy is insured). The four outside corner locations shall be used as a minimum. The AVU shall provide a hard conductive finish at the coldplate mounting interfaces which shall meet a local flatness of 0.002 in/in with an overall flatness of 0.01 inches or better and a maximum surface roughness of 63 micro inches RMS at the interface to the USL coldplate.

C3.2.2.2.1 MASS

The mass of each AVU, including RHD but not including AVU CCD, shall not exceed 48 lb (21.8 Kg).

C3.2.2.3 AVU STRUCTURAL INTERFACES

The AVU shall provide a structural interface to the USL as defined in SSP 30258:006; paragraph 3.4.1.1.4, Structural Load Distribution. The AVU maximum loads supplied to each USL fastener shall not exceed the following:

Axial (lbs)	Shear (lbs)
367	212

C3.2.2.3.1 AVU CENTER OF GRAVITY ENVELOPE

The AVU center of gravity shall be within the Center Of Gravity envelope defined in Figure C3.2.2.3.1–1.

C3.2.2.3.2 STRUCTURAL LOADS FREQUENCY

The AVU shall be designed such that no resonant frequencies occur below 35 Hz when constrained at the mounting interface and exposed to the vibration environments specified in sections C3.2.2.9.12, C3.2.2.9.13, and C3.2.2.9.14.

C3.2.2.4 ELECTRICAL CONNECTORS

The AVU electrical connectors at the interface shall comply with the requirements of SSQ 21635. Connector spacing shall be in accordance with SSP 50005

C3.2.2.5 ELECTRICAL INTERFACES

The USL to AVU electrical interfaces shall be as shown in Figure C3.2.1.5–1.

C3.2.2.5.1 RECEIVE POWER

The primary AVU (LAS5) shall provide the capability to receive power through the AVU2 power circuit. The secondary AVU (LAP5) shall provide the capability to receive power through the AVU1 power circuit. The steady–state current drawn by each AVU shall not exceed 1.6 amps.

C3.2.2.5.1.1 POWER QUALITY

The AVU shall conform to the requirements of “interface C” as defined in SSP 30482, Volume II.

C3.2.2.5.1.2 FAULT PROTECTION

The AVU will receive power via a Type V RPCM with a 3.5 amp current limit as shown in Table C3.2.1.5–1. The inrush current of the AVU shall not exceed 3.8 amps for 10 msec after the application of power.

C3.2.2.5.2 AVU GROUNDING

The AVU grounding interfaces shall meet the requirements of SSP 30240.

C3.2.2.5.3 AVU BONDING

The AVU structural/mechanical interface shall meet the requirements of SSP 30245. Bonding provisions at the coldplate interface shall satisfy a Class R bond in accordance with the above reference document. The bonding path will be through the coldplate. Each AVU will be electrically bonded to the supporting structural by metal–to–metal contact. The AVU shall be finished to provide protection from corrosion with the stainless steel coldplate in accordance with SSP 30245.

C3.2.2.5.4 DELETED

C3.2.2.5.5 ELECTRICAL CONNECTOR DEADFACING

The AVU shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

C3.2.2.5.6 DELETED

C3.2.2.5.7 DELETED

C3.2.2.6 C&DH INTERFACES

The AVU shall communicate as a remote terminal (RT) with the RWS (CEU) with the interface characteristics as specified in MIL–STD–1553B. The AVU shall receive a PDGF local bus stub connection from the USL and as shown in Figure C3.2.1.5–1.

C3.2.2.6.1 AVU CCD INTERFACE

The AVU shall provide a unidirectional TIA/EIA–422 interface to the D&C panel for the AVU Cursor Control Device. The AVU design at the TIA/EIA–422 interface shall be in accordance with paragraph C3.2.1.4.

C3.2.2.6.2 MIL–STD–1553 INTERFACES

C3.2.2.6.2.1 RESPOND TO INPUT SIGNAL AMPLITUDE

The AVU shall provide response message in MIL–STD–1553 format, when receiving suitably addressed messages with MIL–STD–1553 defined waveforms at the CEU interface.

C3.2.2.6.2.2 BUS STUB LENGTH

The AVU shall have a maximum bus stub length of 2 feet as measured from the USL/AVU interface to the isolation transformer as defined in Figure C3.2.1.6.2.3–1.

C3.2.2.6.2.3 MIL–STD–1553 DATA BUS ADDRESSES

Each AVU shall support the definition of its five bit RT address, and a parity bit, by the use of up to six shorting links in the USL data–bus mating connector. Six address selection pins and six ground pins shall be provided for this purpose. A short–circuit to ground shall represent a logic zero, and odd parity will be maintained. The AVU shall not respond to 1553 commands if the parity of the RT address combined with the parity bit is even. The MIL–STD–1553 bus addresses for the AVU RT at the AVU to USL interface shall be 11 for the Primary AVU (LAS5) and 8 for the Secondary AVU (LAP5).

C3.2.2.6.3 DELETED

C3.2.2.6.4 DELETED

C3.2.2.6.5 DELETED

C3.2.2.6.6 DELETED

C3.2.2.7 SYNC, CONTROL, AND VIDEO INTERFACES

The AVU shall receive sync, control, and video interfaces from the USL as shown in Figure C3.2.1.5–1. The AVU shall receive one differential baseband sync signal and two differential baseband video signals from the USL. Each AVU shall have the capability to provide four differential baseband video output signals to the USL.

C3.2.2.7.1 VIDEO, SYNC, AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS

The AVU shall transmit and receive differential baseband video signals, and differential baseband sync and control signals in accordance with EIA–RS–170A and the exceptions as specified in SSP 50002, paragraphs 3.2.1.1.5, and 3.2.1.4.2.

C3.2.2.7.2 AVU UNIQUE OUTPUT VIDEO CHARACTERISTICS

The AVU shall have the capability to pass raw (unprocessed) video from input to output to the RWS when the AVU is powered on or off. The AVU shall pass or insert time code information in the output video in the same output frame and format as specified in SSP 50002.

C3.2.2.8 THERMAL CONTROL SYSTEM INTERFACE CHARACTERISTICS

The AVU shall meet the thermal performance characteristics specified for the USL 683–10041–8 coldplate as defined in SSP 30258:006.

C3.2.2.9 ENVIRONMENTAL INTERFACES

The AVU shall be designed to meet the following environmental conditions:

C3.2.2.9.1 THERMAL (NON OPERATING)

While on orbit, the AVU shall operate after being exposed to an ambient temperature ranging from +40 to +150° F.

C3.2.2.9.2 THERMAL (OPERATING)

While on orbit, the AVU shall operate while being exposed to air temperatures of +55° to +109° F.

C3.2.2.9.3 COLDPLATE TEMPERATURE

The AVU shall meet all operating performance parameters when the Coldplate temperature range is within 33°F to 90°F.

C3.2.2.9.4 HEAT DISSIPATION

The total heat dissipation for the AVU shall be 175 Watts or less.

C3.2.2.9.5 COLDPLATE INTERFACES

Each AVU shall dissipate at least 90% of its total heat load through conduction at the interface with the coldplate. The coldplate interface thermal performance shall be as defined in SSP 30258:006 (683–10041–8 Coldplate). The AVU shall meet all thermal performance parameters as specified in SSP 30258:006 for the 683–10041–8 coldplate.

C3.2.2.9.6 RACK AIR

The AVU shall dissipate no more than 10% of its thermal load into the rack air.

C3.2.2.9.7 OPERATING PRESSURE

The AVU shall meet all performance requirements while being exposed to flight module ambient pressures of 13.9 to 15.2 psia.

C3.2.2.9.8 NON–OPERATING PRESSURE

The AVU shall meet all performance requirements after being exposed to flight module ambient pressures of 13.5 to 15.2 psia.

C3.2.2.9.9 NON–OPERATING TOLERANCE TO DEPRESSURIZATION

In the event of a depressurization and repressurization, the USL to AVU interface shall survive 24 hours at hard vacuum without damage or degradation. For time periods of longer than 24 hours at hard vacuum, the AVU shall be permitted to be removed and replaced, to re–establish normal performance following a depressurization and repressurization event.

Equipment located in pressurized elements other than airlocks shall be capable of withstanding depressurization as indicated by the pressure profile shown in Figure C3.2.2.9.9–1 and a maximum repressurization rate of 2 psi/min.

The air temperature range is dependent on equipment design and location and is predicted by analysis. In order to perform the analysis the following parameters shall be used.

Pressure (psia)	Air Temperature (°F) (1)(2)
15.2 to 9.0	+75 to +5
9.0 to 5.0	+5 to –67
5.0 to 2.0x10^–4	N/A

(1) Air temperature based on isentropic expansion of dry air with an initial temperature of +75°F. They are presented as an aid for analysis and are considered to be worst case.

(2) The radiative environment temperature range during depressurization is +40°F to +75°F.

(3) The cold plate temperature will be maintained between 33oF and 90oF during depressurization.

C3.2.2.9.10 NON–OPERATING AMBIENT HUMIDITY

The AVU shall operate after being exposed to an ambient environment ranging from 0 to 100% relative humidity.

C3.2.2.9.11 OPERATING AMBIENT HUMIDITY

The AVU shall operate while being exposed to 25% to 70% relative humidity.

C3.2.2.9.12 ACCELERATION

The AVU shall support the accelerations described below at all physical interfaces with the module rack.

C3.2.2.9.12.1 NON–OPERATING

The AVU shall operate after exposure to the accelerations shown in Table C3.2.2.9.12.1–1. The accelerations shall be combined with the random vibration environments as defined in SSP 30559.

C3.2.2.9.12.2 OPERATING

The AVU shall operate during exposure to accelerations of .2 g’s in any direction.

The accelerations shall be combined with the random vibration environments as discussed in SSP 30559.

C3.2.2.9.13 NON–OPERATING VIBRATION (LAUNCH)

The AVU shall operate after exposure to the launch vibration levels as shown in Table C3.2.2.9.13–1 for (4) missions. Each mission lasts for 7.5 seconds in duration.

C3.2.2.9.14 OPERATING VIBRATION (ON–ORBIT)

The AVU shall operate while on orbit during exposure to the vibration as shown in Table C3.2.2.9.14–1.

C3.2.2.9.15 ACOUSTIC ENVIRONMENT

The AVU shall operate after exposure to the acoustic spectrum of Table C3.2.2.9.15–1.

C3.2.2.9.16 ACOUSTIC EMANATIONS

Under normal on–orbit operating conditions, the acoustic noise emitted by each AVU measured at a distance of two feet in a frequency range from 63Hz to 8,000 Hz shall not exceed the NC–40 levels shown in Figure C3.2.2.9.16–1.

C3.2.2.9.17 ELECTROMAGNETIC COMPATIBILITY

The AVU shall be designed to be electromagnetically compatible with itself and with all other interfacing surfaces. Equipment shall meet the requirements of SSP 30243, Space Station System Requirements for EMC.

C3.2.2.9.18 ELECTROMAGNETIC INTERFERENCE (EMI)

The AVU shall be designed to meet the requirements of SSP 30237 and SSP 30238.

C3.2.2.9.19 IONIZING RADIATION – TOTAL DOSE

The AVU shall not exhibit any malfunction or degradation of performance beyond tolerances for a total ionizing radiation dose of 2.2 kRad (Si) over 10 years (includes x2 design margin of safety).

C3.2.2.9.20 IONIZING RADIATION – SINGLE EVENT EFFECTS (SEE)

The AVU shall meet the SEE environmental, design and test requirements as specified in SSP 30512 and SSP 30513.

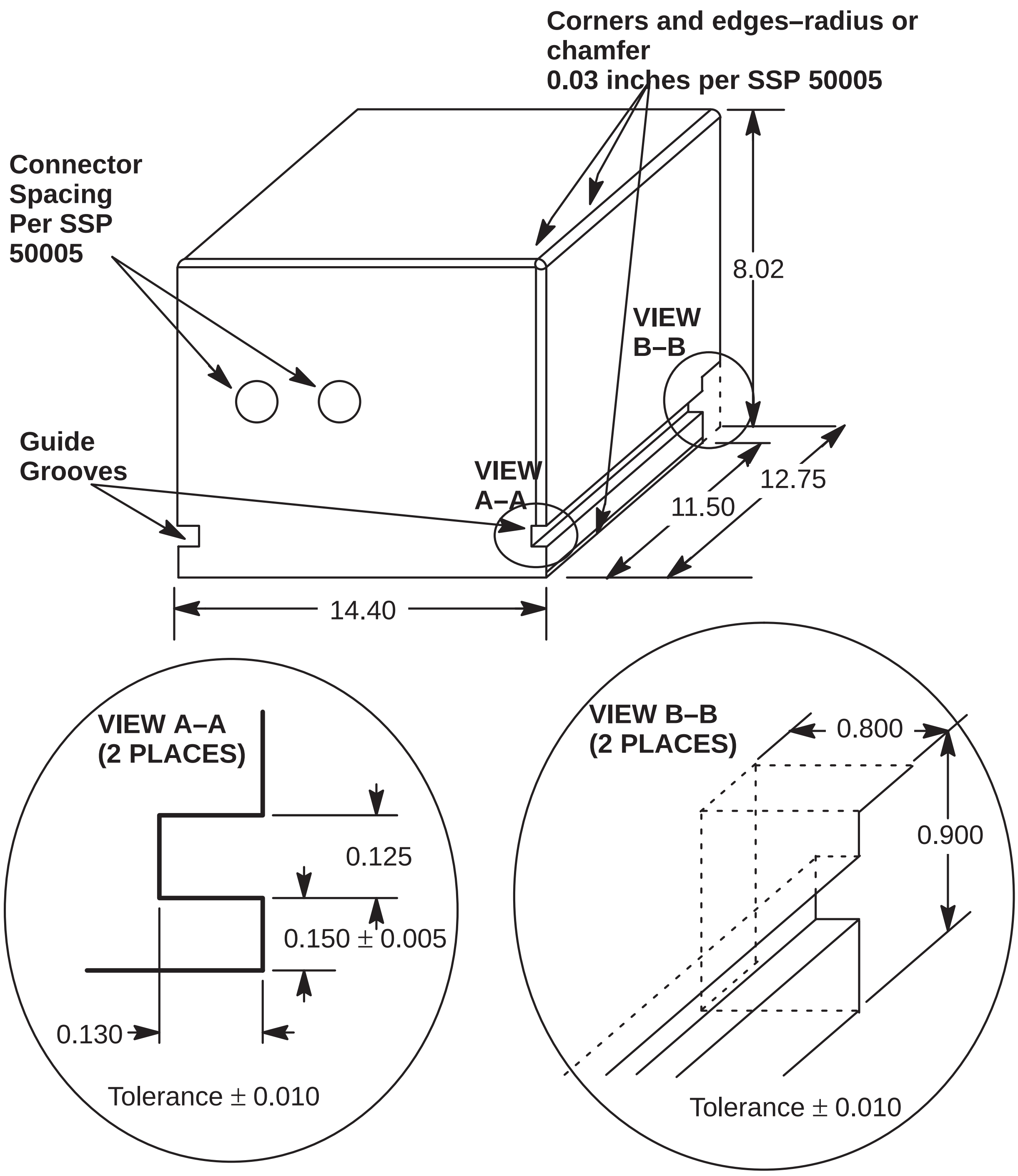
C3.2.2.10 SOFTWARE

The AVU software interfaces to the RWS CEU shall be as specified in CSA–SS–ID–0002, MRCS to AVU ICD.

TABLE C3.1.5–1 AVU TO USL INTERFACE PROVISION RESPONSIBILITIES

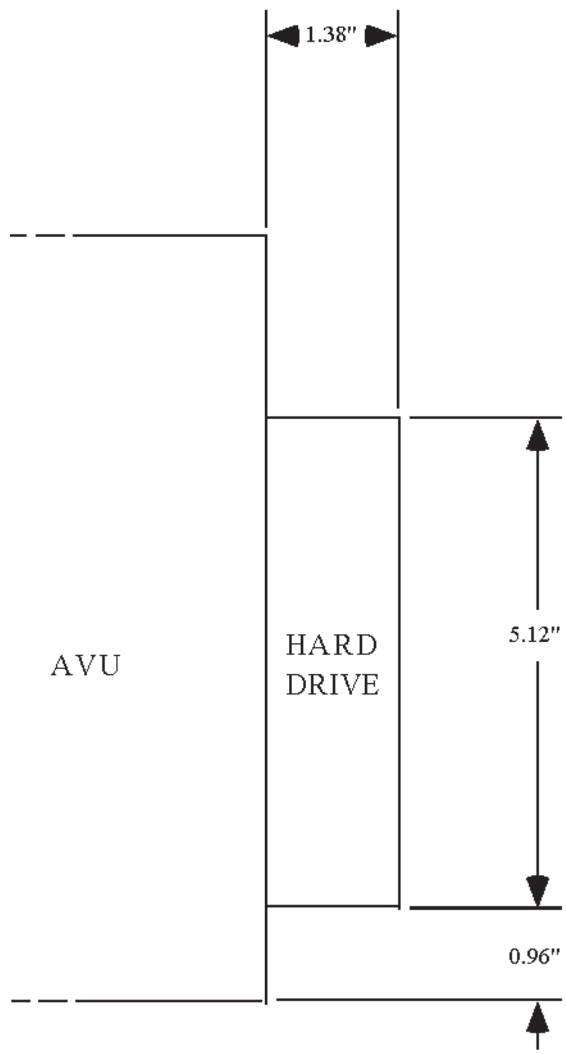
AVU/USL INTERFACE	CSA	NASA
AVU	X	
USL ColdPlates for AVU		X
USL fastener for AVU Attachment to Rack ColdPlate and Shelf		X
USL interconnecting cables to AVU		X
AVU ORU Guide Rails		X
AVU Cursor Control Device (CCD)	X	

Note:
1) The hardware responsibilities above applies to both CSA AVU interfaces with the USL racks. Both LAS–5 and LAP–5 USL racks will be outfitted with an AVU.



VOLUME FOR AVU 1472.0 cubic in. (not including RHD, CCD and Connectors)

FIGURE C3.2.1.1–1 AVU ENVELOPES



Viewed from connector face

Tolerances – xx + .03
– xxx + .001

Note: Hard drive reserved volume extends over entire depth of AVU (12.75 inches), and does not include thumb screw fasteners.

FIGURE C3.2.1.1–2 HARD DRIVE ENVELOPE

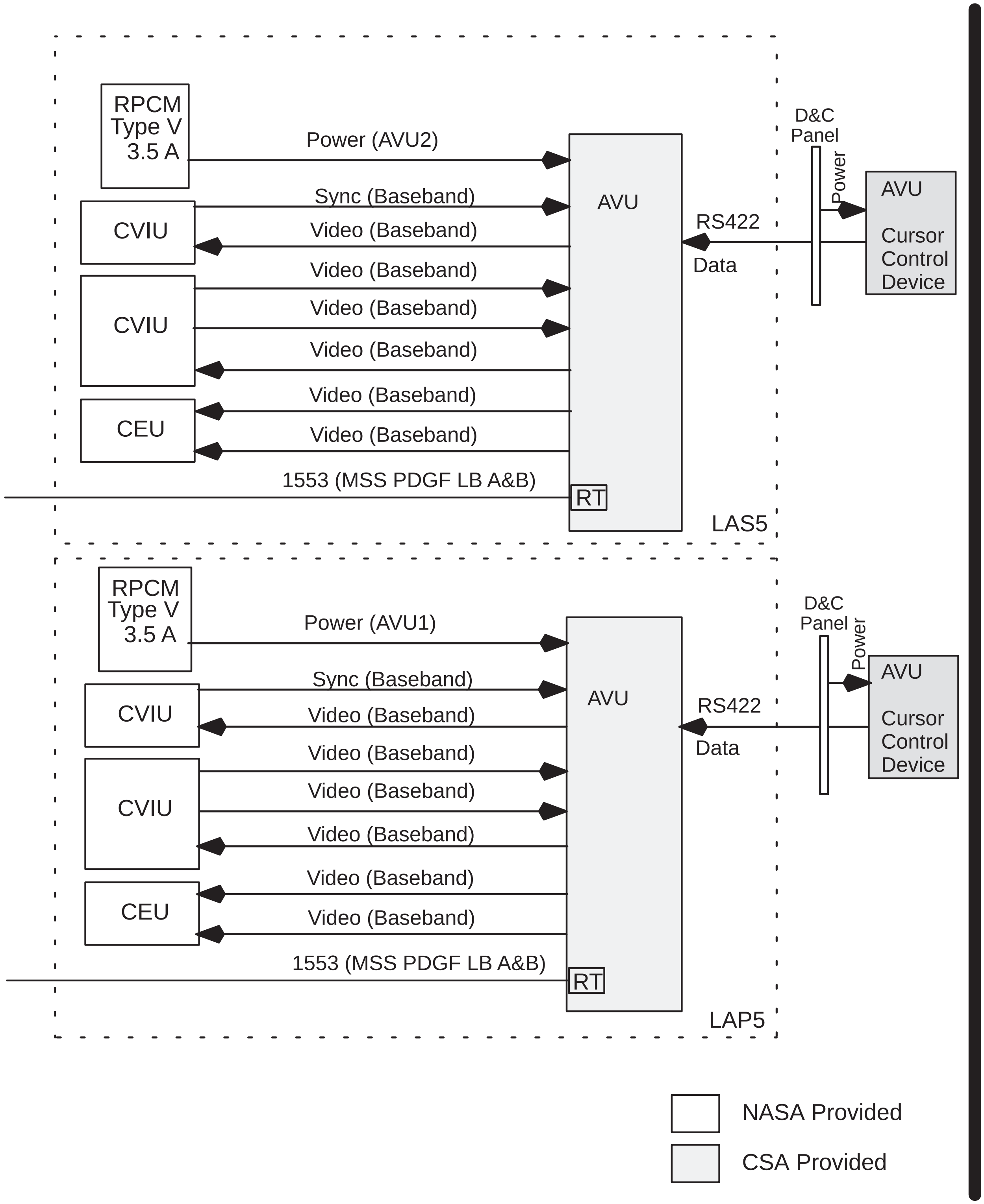


FIGURE C3.2.1.5–1 USL TO AVU ELECTRICAL INTERFACE DIAGRAM

TABLE C3.2.1.5–1 USL TO AVU ELECTRICAL INTERFACE PARAMETERS

Circuit Name	INTERFACE V_{range} (volts)	Operating Current (amps)	Overcurrent Protection
AVU1	113 to 126	0 to 1.6	Note 1
AVU2	113 to 126	0 to 1.6	Note 1

Notes: 1 Protection is equivalent with SSP30263:002, RPCM Standard ICD, RPCM Type V, 3.5 amp.

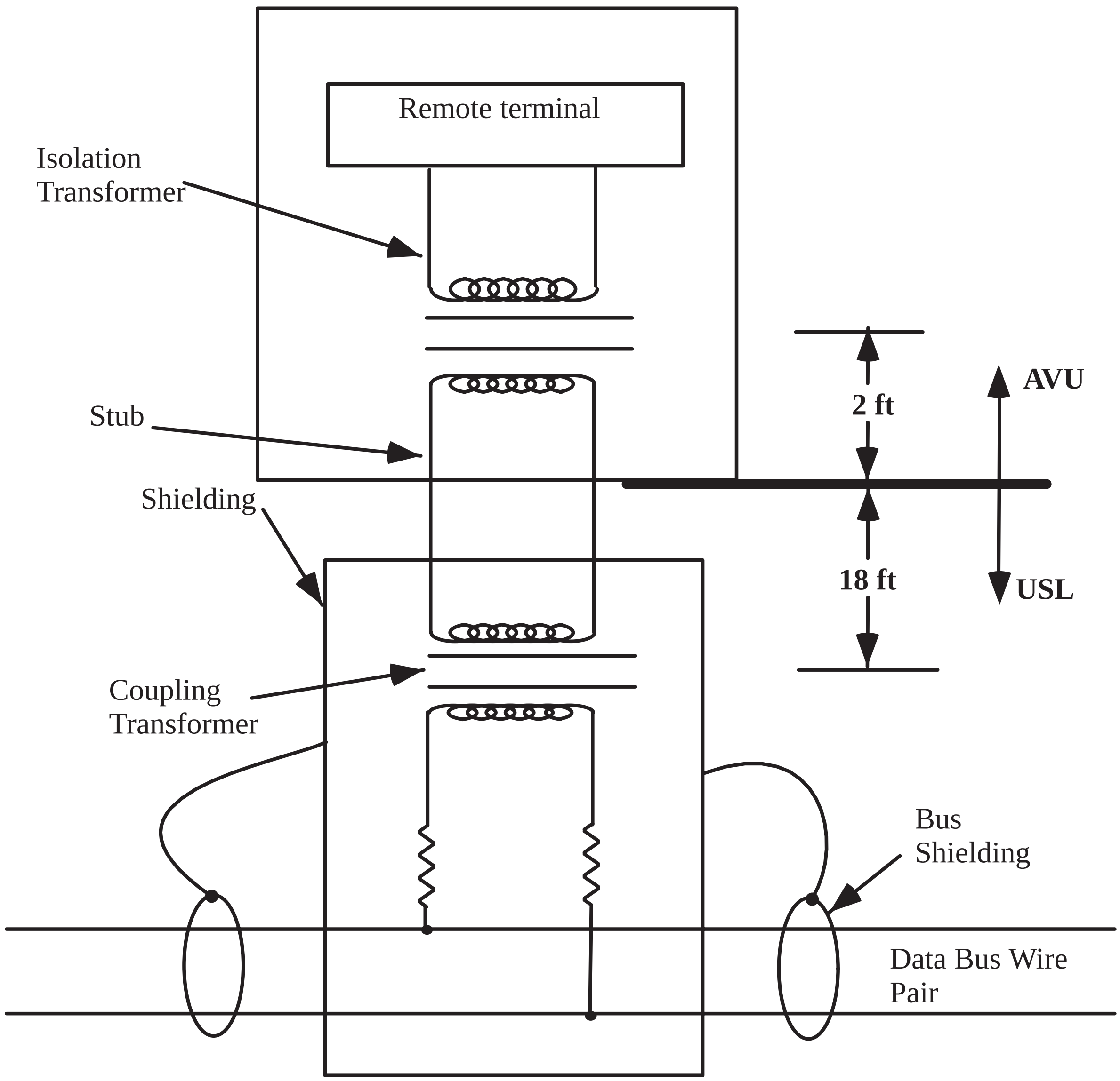
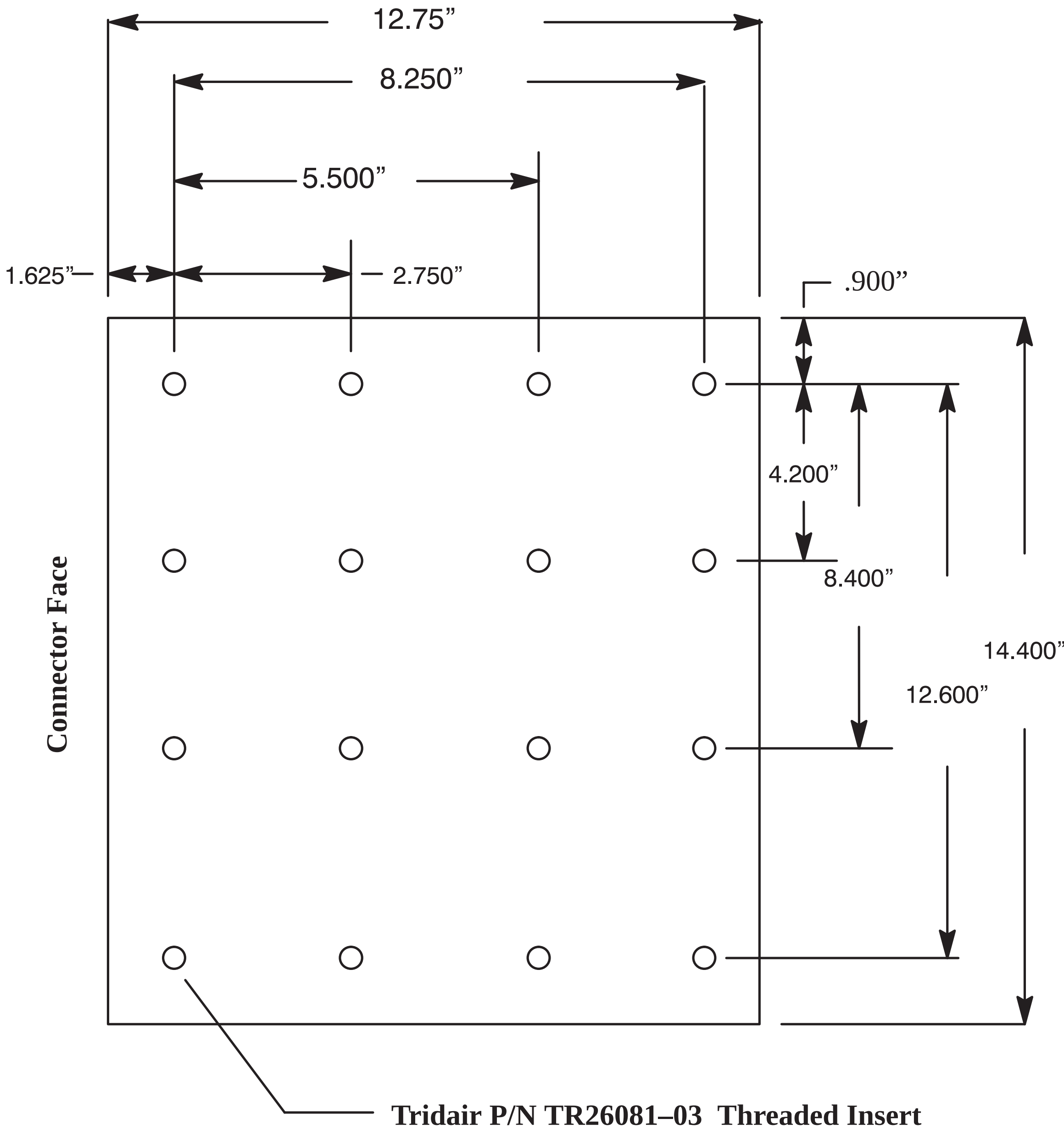
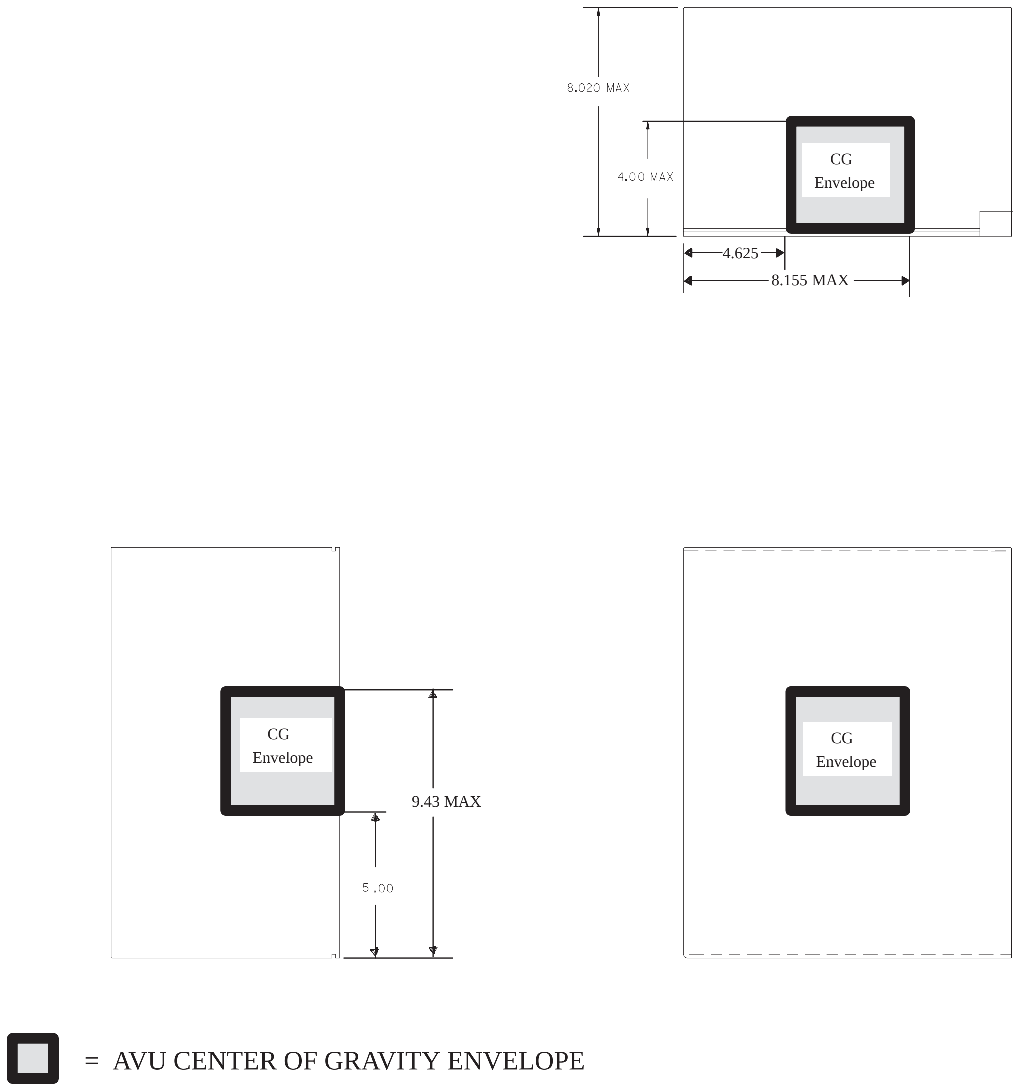


FIGURE C3.2.1.6.2.3–1 USL TO AVU STUB LENGTH ALLOCATION



Note: (1) Center tolerance for threaded inserts within 0.010 inches of indicated position
(2) All sixteen fasteners are used.

FIGURE C3.2.2.2–1 AVU MOUNTING BOLT PATTERN



Note: Launch configuration only, does not include hard drive mass.

FIGURE C3.2.2.3.1–1 AVU CENTER OF GRAVITY ENVELOPE

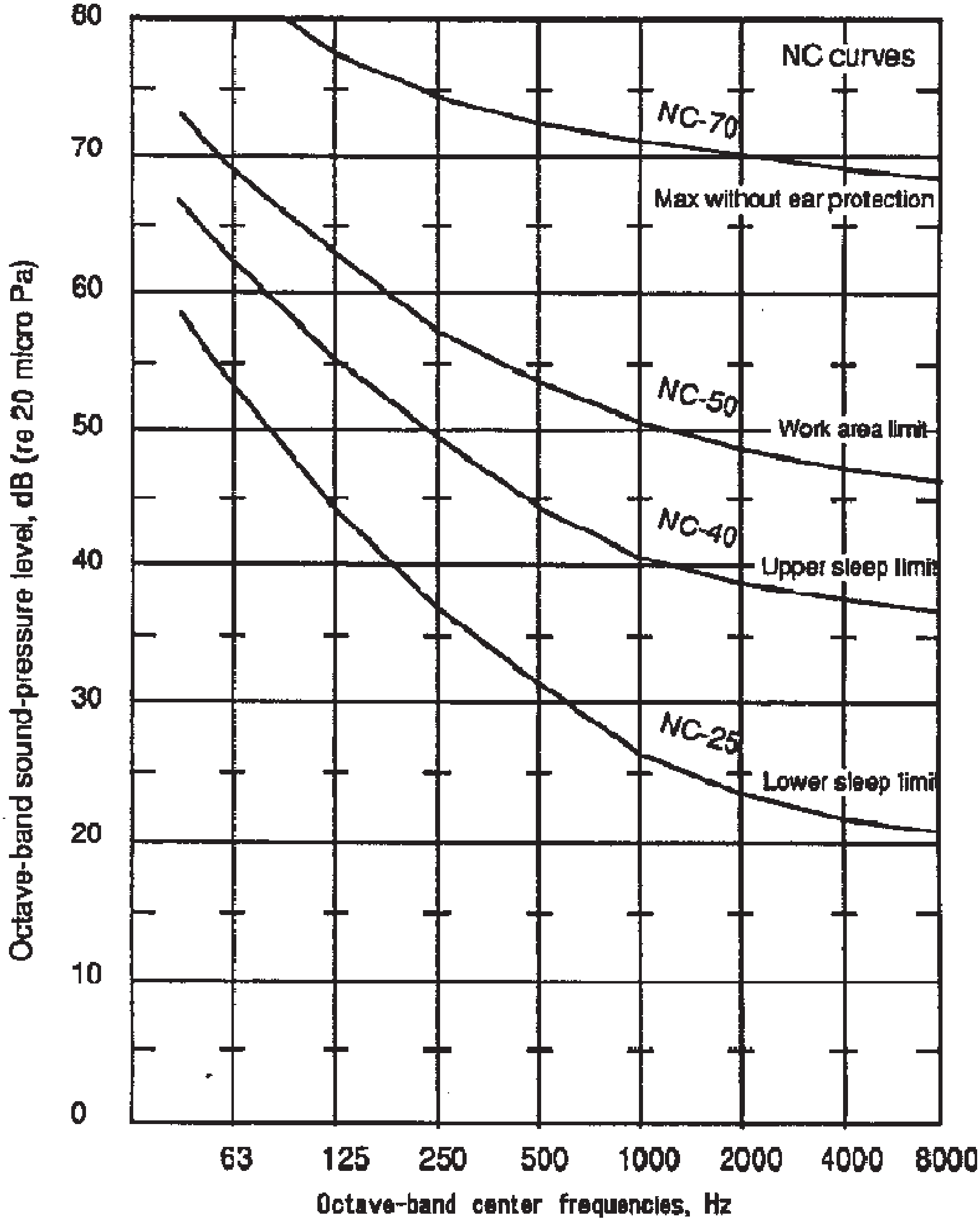


FIGURE C3.2.2.9.16–1 NOISE CRITERIA (NC) CURVES

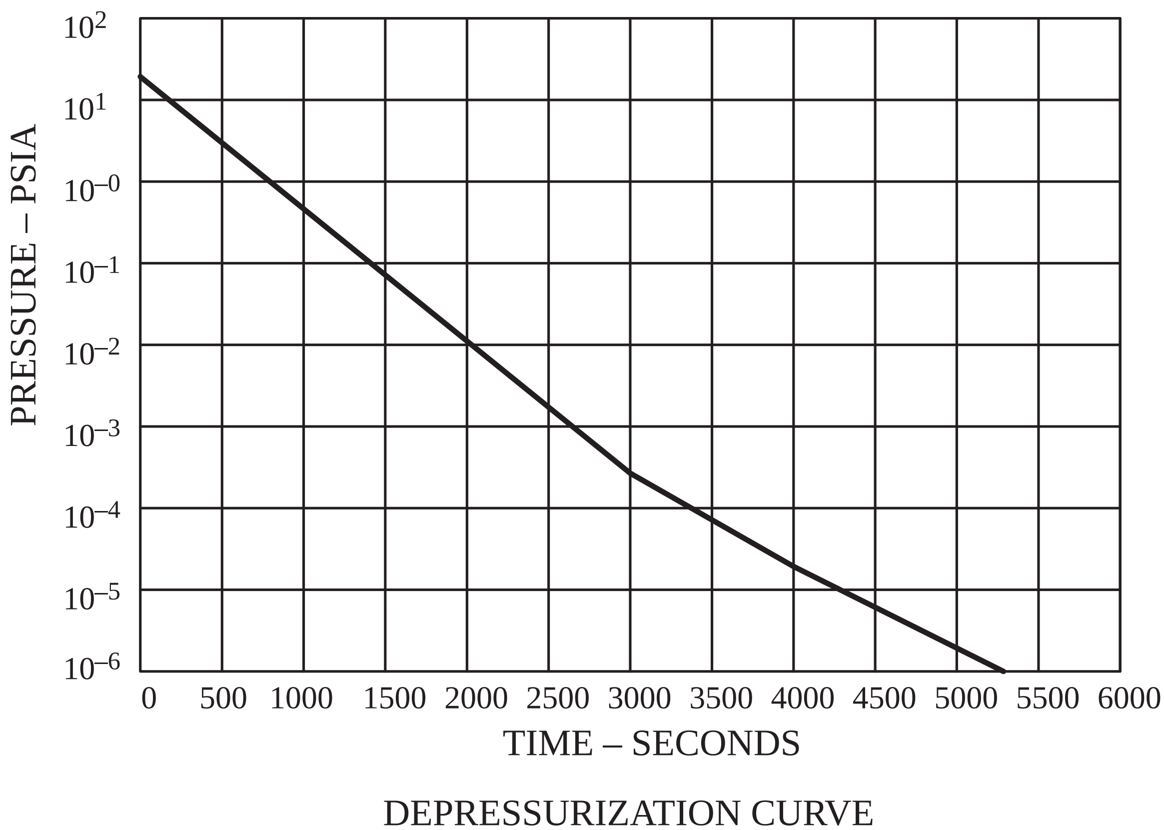


FIGURE C3.2.2.9.9–1 PRESSURIZED ELEMENT DEPRESSURIZATION PROFILE

TABLE C.3.2.1.9.12–1 DELETED

TABLE C.3.2.2.9.12.1–1 LAUNCH ENVIRONMENT, RACK COMPONENT STEADY STATE ACCELERATIONS

Acceleration Direction	Liftoff g's	Landing g's
X	+/– 13.6	+/– 12.2
Y	+/– 11.0	+/– 12.9
Z	+/– 8.3	+/– 8.7

Notes:
1) Accelerations shown are in Rack coordinate system per SSP 30219.
2) Liftoff accelerations shall be combined with launch vibrations per SSP 30559.
3) Accelerations apply concurrently in all possible combinations for each event.

TABLE C3.2.1.9.13–1 DELETED

TABLE C3.2.2.9.13–1 NON–OPERATING LAUNCH RANDOM VIBRATION ENVIRONMENTS FOR EQUIPMENT DESIGN

Location	Frequency	Level
	20 Hz	0.005 g2/Hz
	20–70 Hz	3.3 dB/oct
input to rack	70–200 Hz	0.02 g2/Hz
mounted equipment	200–2000 Hz	–4.0 dB/oct
	2000 Hz	0.00093 g2/Hz
	Composite	3.1 grms

TABLE C3.2.2.9.14–1 ON–ORBIT VIBRATION ENVIRONMENT

Frequency (Hz)	Vibration Level
10–50	0.0005 g^2/Hz
50–100	+3 dB/Octave
100–1000	0.001 g^2/Hz
1000–2000	–3 dB/Octave
2000	0.0005 g^2/Hz
Composite:	1.3 grms
Duration:	10 hours/Year

Notes:
(1) The vibration shall be evaluated as acting one axis at a time in each of three orthogonal axes.
(2) The vibration environment acts concurrently with a steady state acceleration of 0.2 g, acting in any direction.

TABLE C3.2.2.9.15–1 ELEMENT INTERNAL ACOUSTIC SPECTRUM

	Sound Pressure Level (Db) ref. 2X10–5 N/M2
1/3 Octave Band Center Frequency	Liftoff
31.5	106.0
40	109.0
50	111.5
63	114.0
80	116.0
100	117.5
125	118.5
160	119.0
200	119.0
250	118.0
315	117.5
400	115.5
500	112.5
630	109.5
800	107.0
1000	103.0
1250	99.5
1600	95.5
2000	91.5
2500	88.0
3150	83.0
4000	79.0
5000	74.5
6300	70.0
8000	66.0
10000	60.0
Overall	127.5

Duration : 60 seconds + 30 seconds per mission

TABLE C3.2.1.9.17–1 DELETED

SECTION D3 SSMB TO PDGF INTERFACE

D3.0 REQUIREMENTS

D3.1 GENERAL

The PDGF will interface with the modules via mechanical attachments and electrical connections. Harnesses will be provided to support electrical connections to the module connector panel.

D3.1.1 INTERFACE DESCRIPTION

The SSMB to PDGF interfaces consist of structural, mechanical, thermal, environmental, power, data, and video interfaces.

D3.1.2 COORDINATE SYSTEMS

The Space Station integrated stage configurations and elements will be in accordance with the coordinate systems defined in SSP 30219, Space Station Reference Coordinate Systems. The PDGF coordinate system will be as defined in SSP 42004, Section A, MSS to User ICD.

D3.1.3 SSMB INTERFACE FUNCTIONS

The SSMB shall :

A. Provide power distribution to the PDGF harness

B. Circuit protect power to the PDGF harness

C. Control the power supply to the PDGF harness

D. Provide a local bus interface to the PDGF harness

E. Provide video sync and control interface to the PDGF harness

F. Receive video from the PDGF harness

The module shall :

G. Provide mechanical and structural attachments to the PDGF, and PDGF harness

H. Provide a connector panel for the electrical interface

I. Provide utility distribution to the PDGF harness

J. Provide EVA access to interface attachments and connections

K. Provide thermal interfaces

D3.1.4 PDGF AND PDGF HARNESS INTERFACE FUNCTIONS

The PDGF shall :

A. Provide mechanical and structural attachments to the module

B. Provide thermal interfaces

The PDGF harness shall :

C. Provide utility distribution to the module connector panel

D. Receive power from the module connector panel

E. Receive a local bus from the module connector panel

F. Receive video sync and control from the module connector panel

G. Provide video to the module connector panel

D3.1.5 INTERFACE RESPONSIBILITIES

The interface hardware responsibilities will be as defined in Table D3.1.5–1.

D3.2 INTERFACE REQUIREMENTS

D3.2.1 MODULES INTERFACE REQUIREMENTS

D3.2.1.1 MODULE ENVELOPES

D3.2.1.1.1 MODULE EVA ENVELOPE

The modules shall provide an EVA access envelope around the PDGF required for contingency operations as defined in MSS to User ICD, SSP 42004, Section A3.2.2.1.

D3.2.1.1.2 MODULE SSRMS AND SPDM APPROACH ENVELOPE

The modules shall provide an SSRMS and SPDM approach envelope around the PDGF as defined in MSS to User ICD, SSP 42004, Section A3.2.2.1.

D3.2.1.2 MODULE MECHANICAL INTERFACE

a) The module shall mount the PDGF in accordance with SSP 42004, Section A.

b) The modules shall provide an EVA translation path and worksite to the PDGF.

c) The module shall provide attachment mechanisms in accordance with SSP 50005, ISS Flight Crew Standard.

d) The EVA translation aids shall be in accordance with SSP 30256:001, EVA Standard Interface Control Document.

D3.2.1.3 MODULE STRUCTURAL INTERFACES

The module shall meet all performance requirements while being subjected to the SSRMS Base loads as defined below.

Torsional	=	37,800 in–lb (4.27 kN–m)
RSS Bending	=	37,800 in–lb (4.27 kN–m)
RSS Shear	=	225 lbs (1.0 kN)
Tension	=	225 lbs (1.0 kN)

The torsional moment and bending moment will be applied separately.

The shear force and tensile force will be applied separately. One moment and one force can be applied simultaneously

Forces and moments are valid for any direction.

Refer to SSP 42004, Part 1, Section A for SSRMS Tip loads requirements for handling payloads when the SSRMS is relocated onto the modules.

D3.2.1.3.1 PDGF IMPACT LOADS

During grappling of the PDGF by the SSRMS or SPDM, the impact to the module shall be as defined in SSP 42004, Section A, paragraph A3.2.1.3.1.

D3.2.1.3.2 SSMB STIFFNESS REQUIREMENTS

a) The minimum rotational stiffness required from the modules (except the USL) at the PDGF to module interface surface shall be:

Rotational stiffness about X, Y and Z = 825,958 ft–lb/rad (1,119,833 Nm/rad)

b) The minimum rotational stiffness required from the USL at the PDGF to module interface surface shall be:

Rotational stiffness about X and Z	=	720,000 ft–lb/rad (976,176 Nm/rad)
Rotational stiffness about Y	=	650,000 ft–lb/rad (881,270 Nm/rad)

D3.2.1.3.3 INTERFACE LOAD SPECTRUM

The USL shall meet all its performance requirements after being subjected to the load cycles defined in Table D3.2.1.3.3–1 at the PDGF to USL interface.

D3.2.1.4 MODULE ELECTRICAL INTERFACE HARDWARE

a) The module shall provide the capability to tie down the PDGF harnesses.

b) The module shall support a PDGF harness length of less than 10 feet.

D3.2.1.4.1 ELECTRICAL CONNECTORS

The module electrical connectors at the interface shall comply with the requirements of SSQ 21635, General Specifications for Connectors and Accessories, Electrical, Circular, Miniature, IVA/EVA/Robot Compatible, Space Quality.

D3.2.1.5 ELECTRICAL INTERFACES

a) For SSRMS base point operations, the module to PDGF electrical interfaces shall be as shown in Figure D3.2.1.5–1, D3.2.1.5–2, and D3.2.1.5–4 for the USL, HAB, and JEM–PM interfaces respectively (Figure D3.2.1.5–3 Deleted).

b) When the module is an SSRMS user, the module to PDGF electrical interfaces shall be as shown in SSP 42004, Section A3.2.2.5.

D3.2.1.5.1 SUPPLY POWER

The Module shall supply power to the PDGF through the power Circuits specified in Tables D3.2.1.5–1, D3.2.1.5–2 and D3.2.1.5–4 for the USL, HAB and JEM respectively.

D3.2.1.5.1.1 POWER QUALITY

The interface power quality shall be in accordance with SSP 30482, Volumes I and II, Interface B with a steady state voltage range as defined in Tables D3.2.1.5–1, D3.2.1.5–2, and D3.2.1.5–4.

D3.2.1.5.1.2 FAULT PROTECTION

SSMB shall provide protection as shown in Tables D3.2.1.5–1, D3.2.1.5–2 and D3.2.1.5–4.

D3.2.1.5.2 RECEIVE POWER

The Module shall provide the capability to receive power from the PDGF through the power Circuits specified in SSP 42004, Section A3.2.2.5.

D3.2.1.5.3 ELECTRICAL CONNECTOR DEADFACING

The SSMB shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

D3.2.1.5.4 SHIELDING

The module harness shields shall be terminated to structure or chassis at each end.

D3.2.1.5.5 DELETED

D3.2.1.6 C&DH INTERFACES

a) The SSMB shall provide a PDGF local bus (PDGF LB) to the PDGF harness as shown in Figure D3.2.1.6–1.

b) The SSMB shall provide an MSS Backup Drive local bus channel (MSS BUD LB) at the USL and US Hab PDGF locations for the SSRMS backup drive capability as defined in Figure D3.2.1.6–1.

c) The module connector panel shall provide the A channel of the PDGF LB and the B channel of the PDGF LB through separate connectors.

D3.2.1.6.1 PROVIDE OUTPUT AMPLITUDE

SSMB shall provide a signal amplitude of at least 3.6 volts, peak–to–peak, line–to–line, at the PDGF harness interfaces for messages transmitted on the MIL–STD–1553 bus.

D3.2.1.6.2 MIL–STD–1553 DATA BUS ADDRESSES

The MIL–STD–1553 bus addresses for the MSS RT's on the PDGF Local Bus and MSS BUD LB shall be as defined in Tables D3.2.1.6.2–1, and D3.2.1.6.2–2.

D3.2.1.7 SSMB SYNC, CONTROL, AND VIDEO INTERFACES

a) The SSMB shall provide sync, control, and video interfaces to the PDGF harness as shown in Figure D3.2.1.5–1.

b) The SSMB shall provide three video and two sync PFM fiber optic lines to distribute sync and control and to receive video from the PDGF harness.

c) The SSMB fiber optic sync, control, and video interconnect cables shall comply with the requirements of SSQ 21654.

d) The sync and control signal transmitted across the interface shall include the camera commands multiplexed on the signal.

D3.2.1.7.1 SSMB VIDEO, SYNC, AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS

The SSMB shall transmit PFM sync and control and shall receive PFM video from the PDGF harness in accordance with **TBD**.

D3.2.1.7.2 SSMB SYNC AND CONTROL OPTICAL POWER

The SSMB shall transmit the PFM sync and control signal to the PDGF harness with optical power levels which meet as a minimum the values specified in Tables D3.2.1.7.2–1 and D3.2.1.7.2–2.

D3.2.1.7.3 SSMB VIDEO OPTICAL POWER

The SSMB shall receive the PFM video signals from the PDGF harness with optical power levels which meet as a minimum the values specified in Tables D3.2.1.7.3–1 and D3.2.1.7.3–2.

D3.2.1.8 THERMAL INTERFACES

D3.2.1.8.1 PDGF THERMAL INTERFACES

a) During non–operational periods for the PDGF, the SSMB shall be capable of maintaining the PDGF within its non–operational limits of **TBR** (–157 Deg. C to +121 Deg. C).

b) During PDGF operations, the SSMB shall be capable of maintaining the PDGF within its operational limits of **TBR** (–70 Deg. C to +90 Deg. C).

c) The thermal conductance from the SSMB to the PDGF will be **TBR** (3.0 W/Deg. C) maximum.

D3.2.1.8.2 DELETED

D3.2.1.9 ENVIRONMENTS

D3.2.1.9.1 ELECTROMAGNETIC EFFECTS

D3.2.1.9.1.1 ELECTROMAGNETIC COMPATIBILITY

The SSMB interface with the PDGF, and PDGF harness shall meet the requirements of SSP 30243, Space Station Systems Requirements for Electromagnetic Compatibility.

D3.2.1.9.1.2 GROUNDING

The SSMB interface shall meet the requirements of SSP 30240, Space Station Grounding Requirements.

D3.2.1.9.1.3 BONDING

a) The module structural/mechanical interface shall meet the requirements of SSP 30245, Space Station Electrical Bonding Requirements.

b) Bonding provisions at the interface shall satisfy a Class H and R bond in accordance with the above reference document.

D3.2.1.9.1.4 CABLE AND WIRE DESIGN

The module cable and wire interface shall meet the requirements of SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility.

D3.2.1.9.1.5 ELECTROSTATIC DISCHARGE

The module interface shall meet the requirements of SSP 30243.

D3.2.1.9.1.6 CORONA

The module interface shall meet the requirements of SSP 30243.

D3.2.2 PDGF INTERFACE REQUIREMENTS

D3.2.2.1 PDGF HARDWARE ENVELOPES

The SSRMS and SPDM approach envelopes around the PDGF hardware shall be as defined in SSP 42004, Section A3.2.2.1.

D3.2.2.2 PDGF MECHANICAL INTERFACE

a) The PDGF shall provide the mechanical interfaces in accordance with SSP 42004, Section A3.2.1.2.

b) The PDGF shall provide the capability to be installed on orbit to its mounting ring.

c) The PDGF shall provide attachment mechanisms in accordance with SSP 50005.

D3.2.2.3 PDGF STRUCTURAL INTERFACES

The PDGF shall meet all performance requirements while being subjected to the SSRMS Base loads as defined below.

Torsional	=	37,800 in–lb (4.27 kN–m)
RSS Bending	=	37,800 in–lb (4.27 kN–m)
RSS Shear	=	225 lbs (1.0 kN)
Tension	=	225 lbs (1.0 kN)

The torsional moment and bending moment will be applied separately.

The shear force and tensile force will be applied separately. One moment and one force can be applied simultaneously

Forces and moments are valid for any direction.

Refer to SSP 42004, Part 1, Section A for SSRMS Tip loads requirements for handling payloads when the SSRMS is relocated onto the modules.

D3.2.2.3.1 PDGF IMPACT LOADS

During grappling of the PDGF by the SSRMS or SPDM, the impact to the PDGF shall be as defined in SSP 42004, Section A3.2.1.3.1.

D3.2.2.4 PDGF ELECTRICAL INTERFACE HARDWARE

a) The PDGF harnesses shall provide the capability to be tied down on the module and to be mated with the module connector panel.

b) The PDGF harnesses shall not exceed 10 feet.

D3.2.2.4.1 ELECTRICAL CONNECTORS

The PDGF harness electrical connectors at the interface shall comply with the requirements of SSQ 21635.

D3.2.2.5 ELECTRICAL INTERFACES

a) For SSRMS base point operations, the Module to PDGF electrical interfaces shall be as shown in Figures D3.2.1.5–1, D3.2.1.5–2, and D3.2.1.5–4 for the USL, HAB, and JEM interfaces respectively.

b) When the module is an SSRMS user, the module to PDGF electrical interfaces shall be as shown in SSP 42004, Section A3.2.2.5.

D3.2.2.5.1 SUPPLY POWER

The PDGF shall supply power to the Module through the power circuits specified in SSP 42004, Section A3.2.2.5.

D3.2.2.5.2 ELECTRICAL CONNECTOR DEADFACING

The PDGF harness shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

D3.2.2.5.3 SHIELDING

The PDGF harness shields shall be terminated to structure or chassis at each end.

D3.2.2.5.4 RECEIVE POWER

The PDGF shall provide the capability to receive power from each Module through the power circuits specified in Tables D3.2.1.5–1, D3.2.1.5–2 and D3.2.1.5–4 for the USL, HAB and JEM respectively.

D3.2.2.5.4.1 POWER QUALITY

The interface power quality shall be in accordance with SSP 30482, Volumes I and II, Interface B, with a steady state voltage range as defined in Tables D3.2.1.5–1, D3.2.1.5–2, and D3.2.1.5–4.

D3.2.2.5.4.2 FAULT PROTECTION

The modules will provide protection as shown in Tables D3.2.1.5–1, D3.2.1.5–2 and D3.2.1.5–4.

D3.2.2.6 C&DH INTERFACES

a) The PDGF harness shall receive a PDGF local bus PDGF LB from the SSMB as shown in Figure D3.2.1.6–1.

b) The PDGF harness shall receive an MSS Backup Drive local bus (MSS BUD LB) channel at the USL and US Hab PDGF locations for the SSRMS backup drive capability, as defined in Figure D3.2.1.6–1.

c) The PDGF shall receive the A channel of the PDGF local bus (PDGF LB) and the B channel of the PDGF local bus (PDGF LB) through separate connectors.

D3.2.2.6.1 PROVIDE OUTPUT AMPLITUDE

PDGF harness shall provide a signal amplitude of at least 3.6 volts, peak–to–peak, line–to–line, at the SSMB interfaces for messages transmitted on the MIL–STD–1553 bus.

D3.2.2.6.2 MIL–STD–1553 DATA BUS ADDRESSES

The MIL–STD–1553 bus addresses for the Remote Terminals on PDGF LB and MSS BUD LB shall be as defined in Table D3.2.1.6.2–1 and D3.2.1.6.2–2 respectively.

D3.2.2.7 PDGF SYNC, CONTROL, AND VIDEO INTERFACES

a) The PDGF harness shall provide PFM sync, control, and video interfaces with the SSMB as shown in Figure D3.2.1.5–1.

b) The PDGF harness shall receive three PFM video and two PFM sync fiber optic lines.

c) The video transmitted across the interface shall include the camera telemetry multiplexed on the video signal.

d) The PDGF harness fiber optic sync, control, and video interconnect cables shall comply with the requirements of SSQ 21654.

D3.2.2.7.1 PDGF VIDEO, SYNC, AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS

The PDGF harness shall transmit PFM video and receive PFM sync and control in accordance with **TBD**.

D3.2.2.7.2 PDGF SYNC AND CONTROL OPTICAL POWER

The PDGF harness shall receive the PFM sync and control signals with optical power levels which meet as a minimum the values specified in Tables D3.2.1.7.2–1 and D3.2.1.7.2–2.

D3.2.2.7.3 PDGF VIDEO OPTICAL POWER

The PDGF harness shall transmit the PFM video signals with optical power levels which meet as a minimum the values specified in Tables D3.2.1.7.3–1 and D3.2.1.7.3–2.

D3.2.2.8 THERMAL INTERFACES

D3.2.2.8.1 PDGF THERMAL INTERFACES

a) During PDGF non–operational periods, the PDGF shall be maintained within its non–operational temperature limits of **TBR** (–157 Deg. C to +121 Deg. C).

b) During PDGF operational periods, the PDGF shall be maintained within its operational temperature limits of **TBR** (–70 Deg. C to +90 Deg. C).

c) The PDGF shall be designed to provide a maximum thermal conductance of **TBR** (3.0 W/Deg. C) from the PDGF to the SSMB.

D3.2.2.8.2 DELETED

D3.2.2.9 ENVIRONMENTS

D3.2.2.9.1 ELECTROMAGNETIC EFFECTS

D3.2.2.9.1.1 ELECTROMAGNETIC COMPATIBILITY

The PDGF and PDGF harness interface with the module shall meet the requirements of SSP 30243.

D3.2.2.9.1.2 GROUNDING

The PDGF and PDGF harness interface shall meet the requirements of SSP 30240.

D3.2.2.9.1.3 BONDING

a) The PDGF and PDGF harness structural/mechanical interface shall meet the requirements of SSP 30245.

b) Bonding provisions at the interface shall satisfy a Class H and R bond in accordance with the above reference document.

D3.2.2.9.1.4 CABLE AND WIRE DESIGN

The PDGF cable and wire interface shall meet the requirements of SSP 30242.

D3.2.2.9.1.5 ELECTROSTATIC DISCHARGE

The PDGF and PDGF harness interface shall meet the requirements of SSP 30243.

D3.2.2.9.1.6 CORONA

The PDGF and PDGF harness interface shall meet the requirements of SSP 30243.

TABLE D3.1.5–1 INTERFACE HARDWARE RESPONSIBILITY

PDGF Interface Hardware Responsibilities(1)	NASA Hardware	CSA Hardware
SSRMS		X
SPDM		X
PDGF ORU for modules	X	
PDGF bolts	X	
Module bolt holes for PDGF	X	
PDGF harnesses	X	
Module utility distribution	X	
Module connector panel	X	
Harness tie down points	X	

Note:

1) PDGFs are designed, developed, and verified by CSA and supplied by NASA as GFE. The PDGF harnesses are designed, developed, verified, and supplied by NASA. The PDGF harness is terminated with connectors provided by NASA. PDGF bolts are the responsibility of the module integrator.

TABLE D3.2.1.3.3–1 USL TO PDGF CYCLE LOADS

Axial/Shear Force		Torque/Moment		Cycles
N	lb	N m	lb ft	
1000	225	3100	2288	3
180	40	2712	2000	10
0	0	4407	3250	5
0	0	4068	3000	1715
0	0	3729	2750	1028
0	0	3390	2500	1025
0	0	3051	2250	5140
0	0	2712	2000	11283
0	0	2372	1750	20505
0	0	2034	1500	22573
0	0	1695	1250	54043
0	0	1356	1000	84198
0	0	1017	750	154250
0	0	678	500	265088
0	0	339	250	390370

Notes: 1 Data contains no margins or scatter factors.
2 PDGF is in latched condition.
3 Apply forces in each axis, (x, y, z as defined in SSP 42004, Figure A3.1.2–1) and moments about each axis simultaneously.

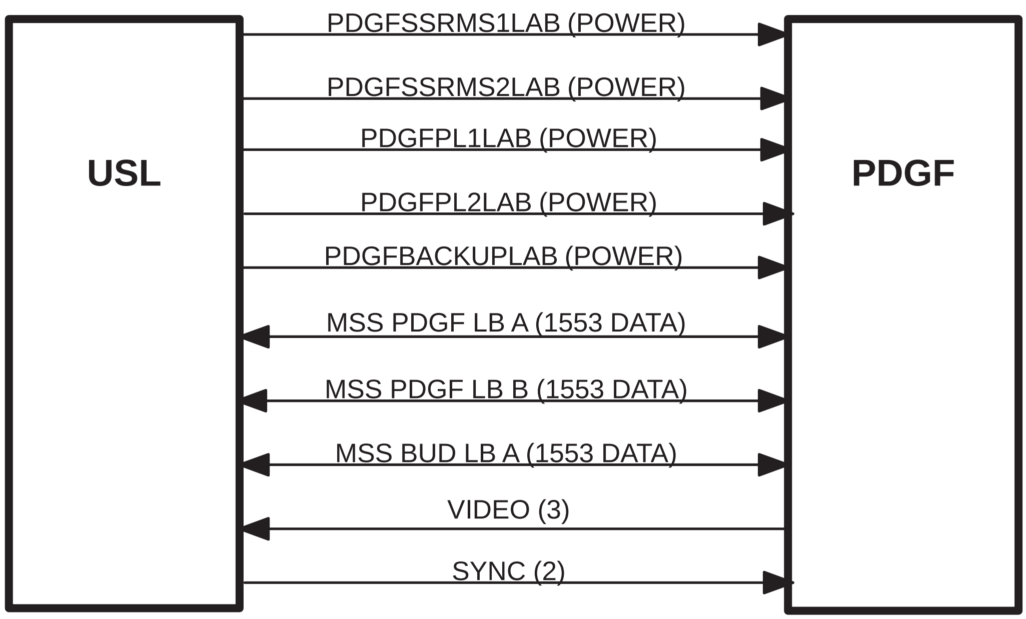


FIGURE D3.2.1.5–1 USL TO PDGF ELECTRICAL INTERFACES

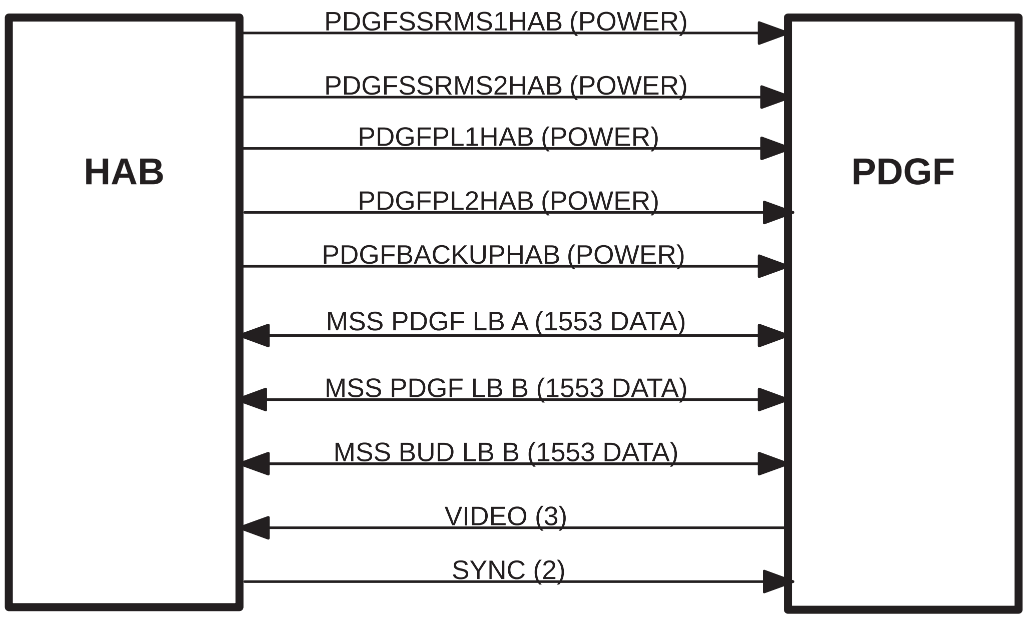


FIGURE D3.2.1.5–2 HAB TO PDGF ELECTRICAL INTERFACES

DELETED

FIGURE D3.2.1.5–3 DELETED

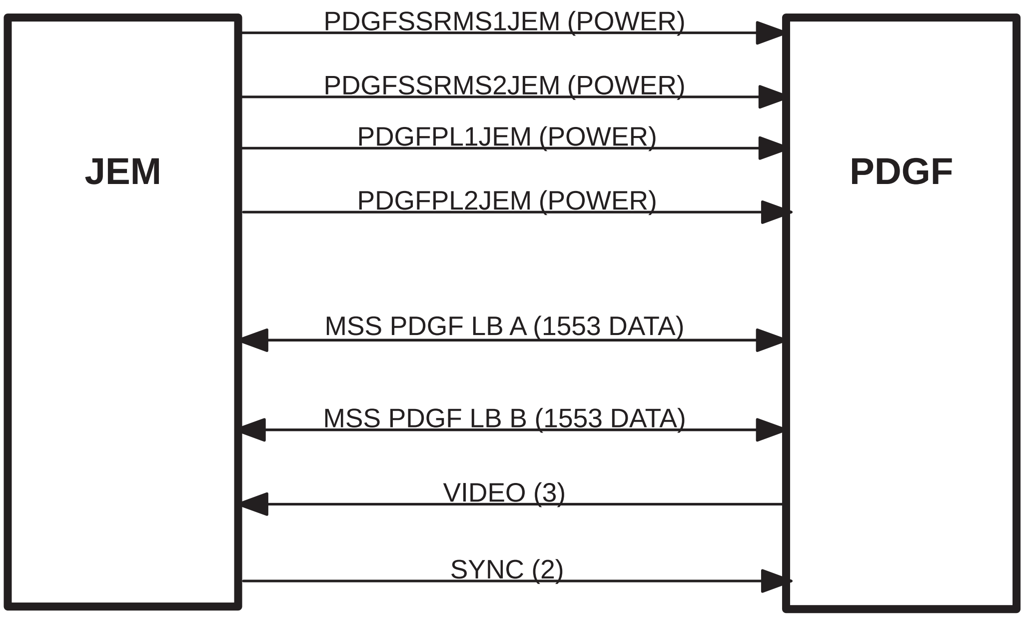


FIGURE D3.2.1.5–4 JEM TO PDGF ELECTRICAL INTERFACES

TABLE D3.2.1.5–1 USL TO PDGF ELECTRICAL INTERFACE PARAMETERS

Circuit Name	Interface V_{range} (volts)	Operating Current (amps)	Overcurrent Protection
PDGFSSRMS1LAB	114 to 126	0 to 17.5	Note 3 or Note 1
PDGFSSRMS2LAB	114 to 126	0 to 17.5	Note 3 or Note 1
PDGFPL1LAB	114 to 126	0 to 17.5	Note 1
PDGFPL2LAB	114 to 126	0 to 17.5	Note 1
PDGFBACKUPLAB	114 to 126	0 to 4.4	Note 2

Notes:
1 Protection shall be equivalent with SSP30263:002, Type II RPCM Standard ICD.
2 Protection shall be equivalent with SSP30263:002, Type V, 12 amp, RPCM Standard ICD.
3 Protection shall be equivalent with SSP30263:002, Type VI RPCM Standard ICD.
4 DELETED
5 SSRMS operate from 113 volt DC minimum at the base LEE to PDGF interface.

TABLE D3.2.1.5–2 HAB TO PDGF ELECTRICAL INTERFACE PARAMETERS

Circuit Name	Interface V_{range} (volts)	Operating Current (amps)	Overcurrent Protection
PDGFSSRMS1HAB	114 to 126	0 to 17.5	Note 1
PDGFSSRMS2HAB	114 to 126	0 to 17.5	Note 1
PDGFPL1HAB	114 to 126	0 to 17.5	Note 1
PDGFPL2HAB	114 to 126	0 to 17.5	Note 1
PDGFBACKUPHAB	114 to 126	0 to 4.4	Note 2

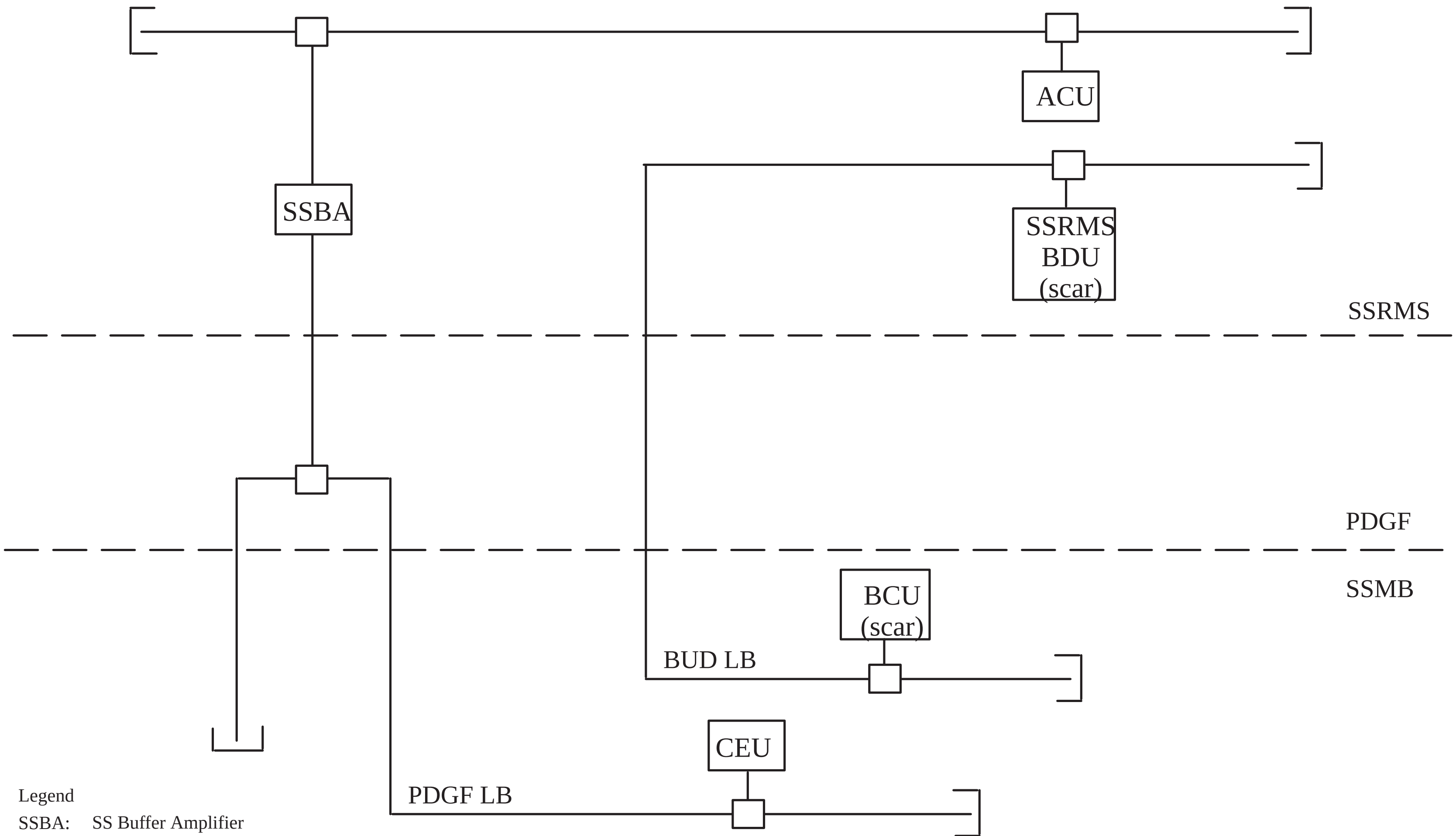
Notes: 1 Protection shall be equivalent with SSP30263:002, Type II RPCM Standard ICD.
2 Protection shall be equivalent with SSP30263:002, Type V, 12 amp, RPCM, Standard ICD.
3 SSRMS operate from 113 volt DC minimum at the base LEE to PDGF interface.

TABLE D3.2.1.5–3 DELETED

TABLE D3.2.1.5–4 JEM–PM TO PDGF ELECTRICAL INTERFACE PARAMETERS

Circuit Name	Interface V_{range} (volts)	Operating Current (amps)	Overcurrent Protection
PDGFSSRMS1JEM	114 to 126	0 to 17.5	Note 1
PDGFSSRMS2JEM	114 to 126	0 to 17.5	Note 1
PDGFPL1JEM	114 to 126	0 to 17.5	Note 1
PDGFPL2JEM	114 to 126	0 to 17.5	Note 1

1 Protection is equivalent with SSP30263:002, Type II RPCM Standard ICD.
2 SSRMS operates from 113 volt DC minimum at the base LEE to PDGF interface.



Legend

SSBA:	SS Buffer Amplifier
□	Bus Coupler
⎿	Bus Termination
ACU:	SSRMS Arm Control Unit
CEU:	Control Electronics Unit
BCU:	Backup Drive Control Unit
BDU:	Backup Drive Unit

FIGURE D3.2.1.6–1 PDGF LB CONFIGURATION

TABLE D3.2.1.6.2–1 PDGF LB ADDRESSES (PAGE 1 OF 2)

Bus:	PDGF LB		
Figure Reference	Long Name	RT Address	Location
None	Not used	0	None
None	Reserved (SPDM BDU Default address)	1	None
None	Payload RT (generic)	2	Note 2
None	Not used	3	None
None	Payload RT (generic)	4	Note 2
RWS CEU–2	Robotics Workstation Control Electronics Unit #2	5	USL
SPDM PSU	SPDM Power Switching Unit	6	SPDM
None	Payload RT (generic)	7	Note 2
None	AVU LAP5	8	LAP5
None	Not used	9	None
None	Not used	10	None
None	AVU LAS5	11	LAS5
RWS CEU–1	Robotics Workstation Control Electronics Unit #1	12	USL
None	Not used	13	None
ACU –R IOC	Arm Control Unit –R Input/Output Card	14	SSRMS
ACU –R Safing RT	Arm Control Unit –R Safing RT	15	SSRMS
SPDM BDU	SPDM Backup Drive Unit	16	SPDM
ACU1 Safing RT	SPDM ACU1 Safing RT	17	SPDM
ACU1 IOC	SPDM ACU1 Input/Output Card	18	SPDM
SCU #2 Safing RT	SPDM ACU2 Safing RT	19	SPDM
SCU #2 IOC	SPDM ACU2 Input/Output Card	20	SPDM
None	Payload RT (generic)	21	Note 2
MCU –R IOC	MBS Control Unit –R Input/Output Card	22	MBS
MCU–R Safing RT	MBS Control Unit –R Safing RT	23	MBS
None	Not used	24	None
None	Not used	25	None
MCU IOC	MBS Control Unit Input/Output Card	26	MBS
MCU Safing RT	MBS Control Unit Safing RT	27	MBS
None	Not used	28	None

TABLE D3.2.1.6.2–1 PDGF LB ADDRESSES (PAGE 2 OF 2)

Bus:	PDGF LB		
ACU Safing RT	Arm Control Unit Safing RT	29	SSRMS
ACU IOC	Arm Control Unit Input/Output Card	30	SSRMS
None	Reserved (1553B Broadcast Address)	31	None

Notes: 1) MBS is located on the PDGF local bus prior to installation
2) Generic payloads can use any of the payload RT addresses on this bus.

TABLE D3.2.1.6.2–2 MSS BUD LB (PAGE 1 OF 2)

Bus:	MSS BUD LB		
Figure Reference	Long Name	Address	Location
None	Reserved	0	None
None	Reserved	1	None
None	Reserved	2	None
None	Reserved	3	None
None	Reserved	4	None
None	Reserved	5	None
None	Reserved	6	None
None	Reserved	7	None
None	Reserved	8	None
None	Reserved	9	None
None	Reserved	10	None
None	Reserved	11	None
None	Reserved	12	None
None	Reserved	13	None
None	Reserved	14	None
None	Reserved	15	None
SSRMS BDU	SSRMS Backup Drive Unit	16	SSRMS
None	Reserved	17	None
None	Reserved	18	None
None	Reserved	19	None
None	Reserved	20	None
None	Reserved	21	None
None	Reserved	22	None
None	Reserved	23	None
None	Reserved	24	None
None	Reserved	25	None
None	Reserved	26	None
None	Reserved	27	None
None	Reserved	28	None

TABLE D3.2.1.6.2–2 MSS BUD LB (PAGE 2 OF 2)

Bus:	MSS BUD LB		
RWS BCU–2	Robotics Workstation Back–up Drive Control Unit #2	29	LAS5
RWS BCU–1	Robotics Workstation Back–up Drive Control Unit #1	30	LAP5
None	Reserved (1553B Broadcast Address)	31	None

TABLE D3.2.1.7.2–1 SSMB SYNC OPTICAL POWER (TEMPORARY LINES BETWEEN FLIGHTS 6A AND 8A)

End to End Link Description		NASA 400 Series Connector Interface	CSA 400 Series Connector Interface
Sync Source	Sync Destination	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)
Sync #2	USL PDGF VSC	–18.0	–20.0
Sync #1	USL PDGF VSC	–18.0	–20.0

Note: Maximum optical power level will not exceed –10 dBm at the CSA interface.

TABLE D3.2.1.7.2–2 SSMB SYNC OPTICAL POWER (FLIGHTS 8A THROUGH 19A)

End to End Link Description		NASA 300 Series Connector Interface	NASA 400 Series Connector Interface	CSA 400 Series Connector Interface
Sync Source	Sync Destination	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)
Sync #1	JEM–PM PDGF VSC	–15.2	–17.6	–20.0
Sync #2	JEM–PM PDGF VSC	–15.2	–17.6	–20.0
Sync #1	USL PDGF VSC	–14.8	–17.3	–20.0
Sync #2	USL PDGF VSC	–14.8	–17.3	–20.0
Sync #1	HAB PDGF VSC	–15.8	–17.9	–20.0
Sync #2	HAB PDGF VSC	–15.8	–17.9	–20.0

Note: Maximum optical power level will not exceed –10 dBm at the CSA interface.

TABLE D3.2.1.7.3–1 SSMB VIDEO OPTICAL POWER (TEMPORARY LINES BETWEEN FLIGHTS 6A AND 8A)

End to End Link Description		CSA 400 Series Connector Interface	NASA 400 Series Connector Interface
Video Source	Video Destination	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)
USL PDGF VSC	VSU 2 Link 1	–14.0	–15.5
USL PDGF VSC	VSU 2 Link 2	–14.0	–15.5
USL PDGF VSC	VSU 1	–14.0	–15.5

Note: Maximum optical power level will not exceed –8 dBm at the CSA interface.

TABLE D3.2.1.7.3–2 SSMB VIDEO OPTICAL POWER (FLIGHTS 8A THROUGH 19A)

End to End Link Description		CSA 400 Series Connector Interface	NASA 400 Series Connector Interface	NASA 300 Series Connector Interface
Video Source	Video Destination	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)
JEM–PM PDGF VSC	VSW 1	–14.6	–16.7	–18.9
JEM–PM PDGF VSC	VSW 3	–14.6	–16.7	–18.9
JEM–PM PDGF VSC	VSW 2	–14.6	–16.7	–18.9
USL PDGF VSC	VSW 1	–15.1	–17.4	–20.1
USL PDGF VSC	VSW 3	–15.1	–17.4	–20.1
USL PDGF VSC	VSW 2	–15.1	–17.4	–20.1
HAB PDGF VSC	VSW 2	–14.3	–16.2	–18.1
HAB PDGF VSC	VSW 3	–14.3	–16.2	–18.1
HAB PDGF VSC	VSW 1	–14.3	–16.2	–18.1

Note: Maximum optical power level will not exceed –8 dBm at the CSA interface.

SECTION E3 PWP TO MBS INTERFACE

E3.0 REQUIREMENTS

E3.1 GENERAL

The MBS will interface with the PWP via mechanical attachments.

E3.1.1 INTERFACE DESCRIPTION

The MBS will provide one Worksite Interface Fixture (WIF) which will structurally support the mounting of the PWP to the MBS. The FRGF will structurally interface with the base of the PWP. The SSRMS will interface with the FRGF on the PWP as defined in SSP 42004, Section I. There are no PWP to MRS electrical interfaces.

E3.1.2 COORDINATE SYSTEMS

The Space Station integrated stage configurations and elements will be in accordance with the coordinate systems defined in SSP 30219, Space Station Reference Coordinate Systems.

E3.1.3 PWP INTERFACE FUNCTIONS

The PWP shall :

A. Provide mechanical and structural attachment to the MBS

B. Provide EVA access to interface attachments

E3.1.4 MBS INTERFACE FUNCTIONS

The MBS shall :

A. Provide mechanical and structural attachment of the PWP

B. Provide EVA access to interface attachments and connections

C. Provide a envelope on the MBS for transporting and stowing the PWP

E3.1.5 INTERFACE RESPONSIBILITIES

The interface hardware responsibilities will be as defined in Table E3.1.5–1.

E3.2 INTERFACE REQUIREMENTS

E3.2.1 PWP INTERFACE REQUIREMENTS

E3.2.1.1 PWP HARDWARE ENVELOPES

The PWP stowage envelope on the MBS shall be as defined in Figures E3.2.1.1–1 through E3.2.1.1–4.

E3.2.1.2 PWP MECHANICAL INTERFACE

The PWP shall provide a probe which is compatible with the WIF socket as defined in SSP 30256:001, EVA Standard Interface Control Document.

E3.2.1.3 PWP STRUCTURAL INTERFACES

The PWP maximum loads associated with the PWP probe at the MBS WIF socket interface shall be as defined in SSP 30256:001.

E3.2.1.4 PWP THERMAL INTERFACE

The thermal interfaces associated with the PWP probe at the MBS WIF socket interface shall be as defined in SSP 30256:001, EVA Standard Interface Control Document.

E3.2.2 MBS INTERFACE REQUIREMENTS

E3.2.2.1 MBS HARDWARE ENVELOPE

a) The MBS shall provide an EVA and installation envelope for mating to the PWP.

b) The attachment mechanisms shall comply with SSP 50005.

E3.2.2.2 MBS MECHANICAL INTERFACE

a) The MBS shall provide a mechanical interface for the PWP.

b) The MBS shall provide a WIF to interface with the PWP probe in accordance with SSP 30256:001, EVAS Standard Interface Control Document.

E3.2.2.3 MBS STRUCTURAL INTERFACES

The maximum loads associated with the PWP at the MBS WIF socket interface shall be as defined in SSP 30256:001.

E3.2.2.3.1 WIF WEIGHT

The weight of the WIF shall be defined in accordance with SSP 30256:001.

E3.2.2.4 MBS THERMAL INTERFACES

The thermal interfaces associated with the PWP at the MBS WIF socket interface shall be as defined in SSP 30256:001.

TABLE E3.1.5–1 INTERFACE HARDWARE RESPONSIBILITIES

MBS/PWP INTERFACE	NASA	CSA
– PWP (with WIF probe)	X	
– MBS (with WIF)		X

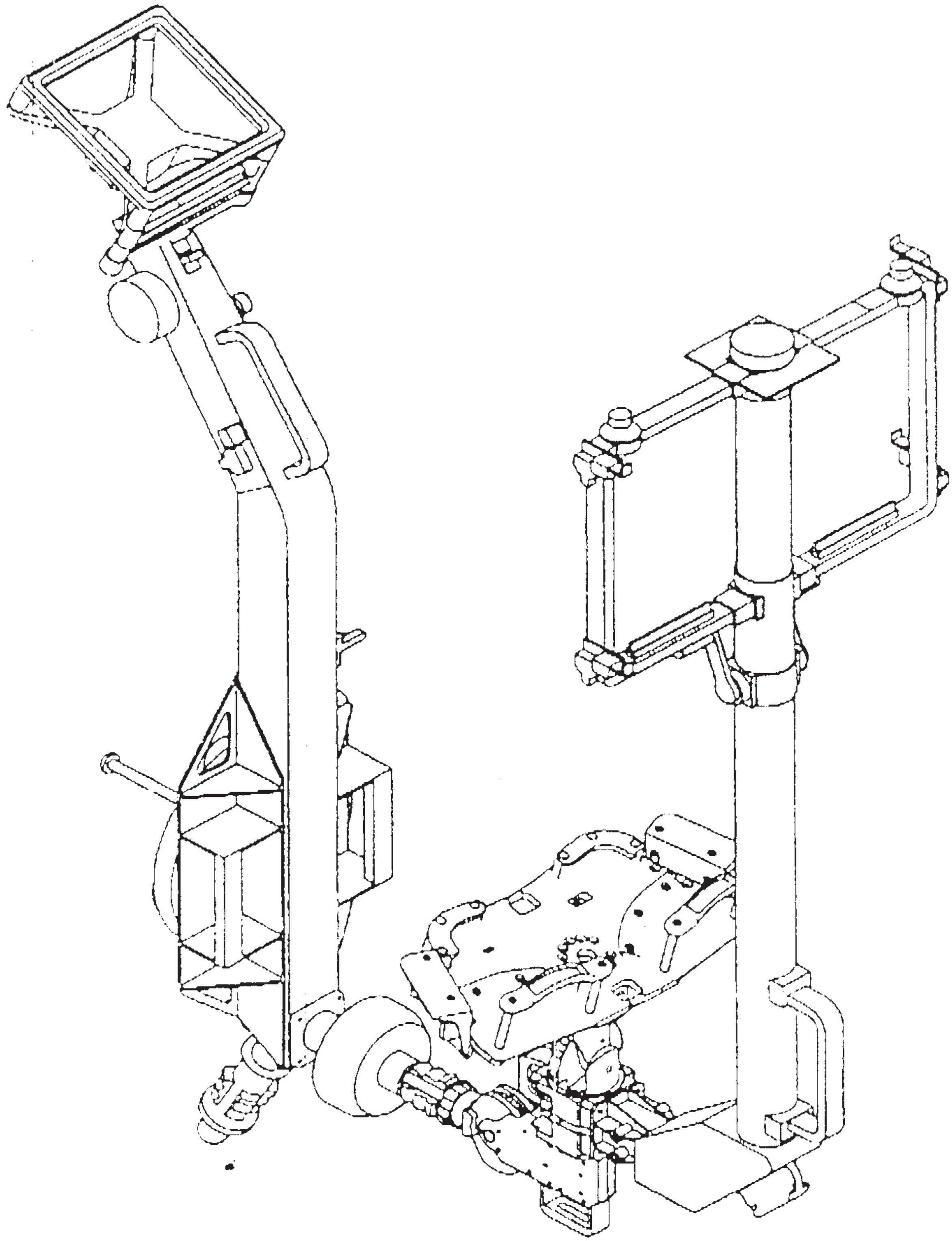


FIGURE E3.2.1.1–1 PWP STOWAGE ENVELOPE (PAGE 1 OF 4)

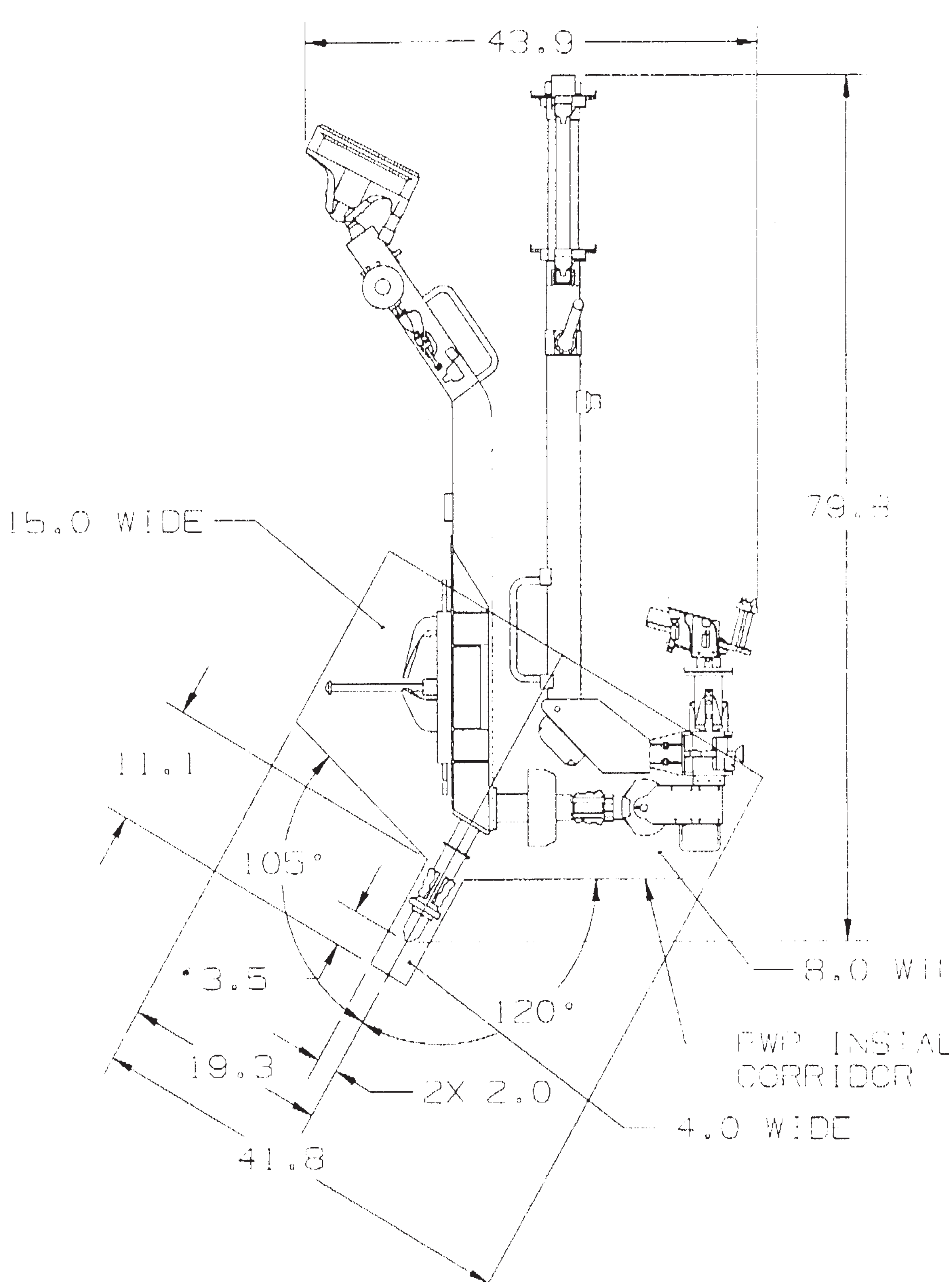


FIGURE E3.2.1.1–2 PWP STOWAGE ENEVELOPE (PAGE 2 OF 4)

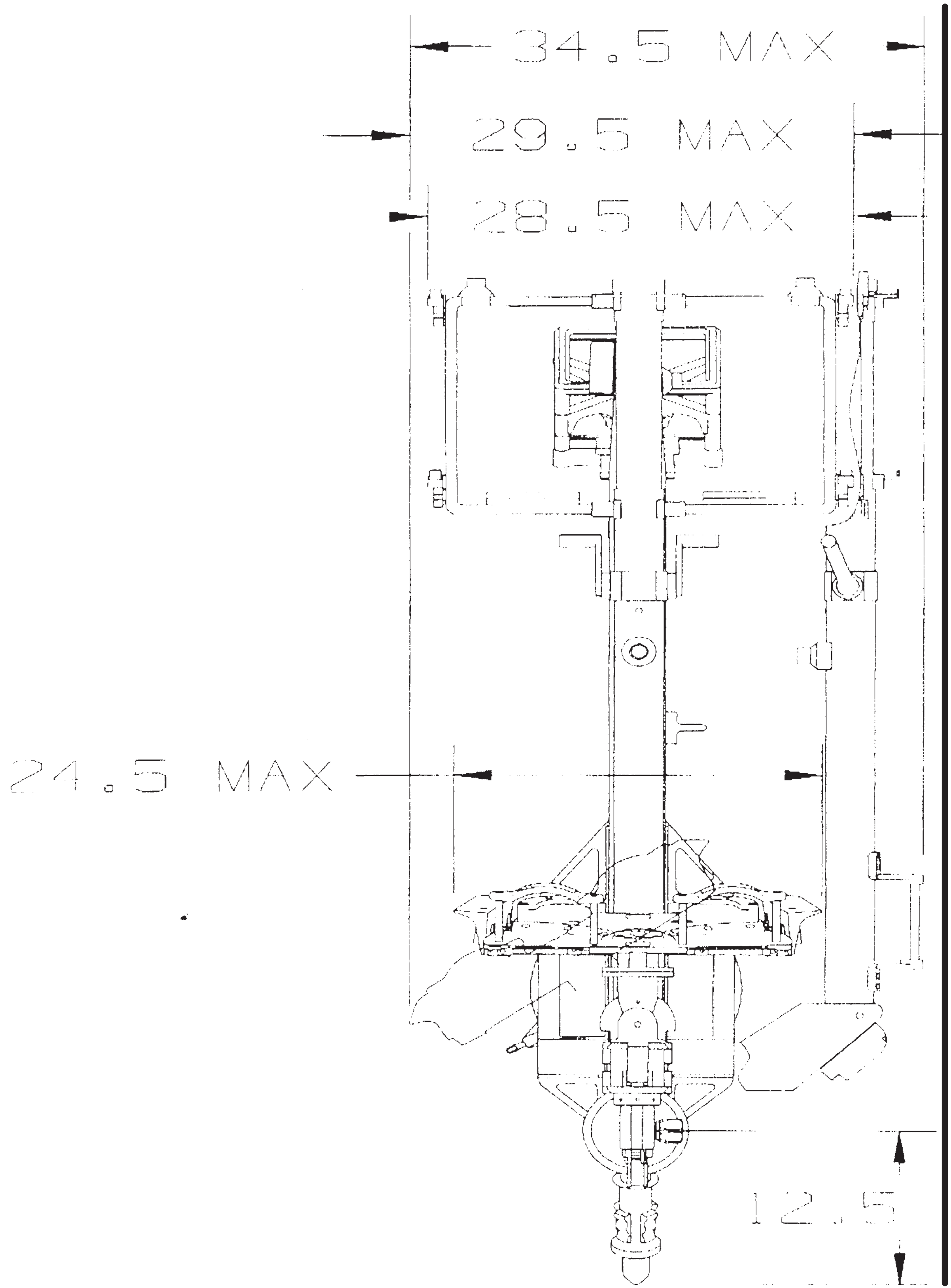


FIGURE E3.2.1.1–3 PWP STOWAGE ENVELOPE (PAGE 3 OF 4)

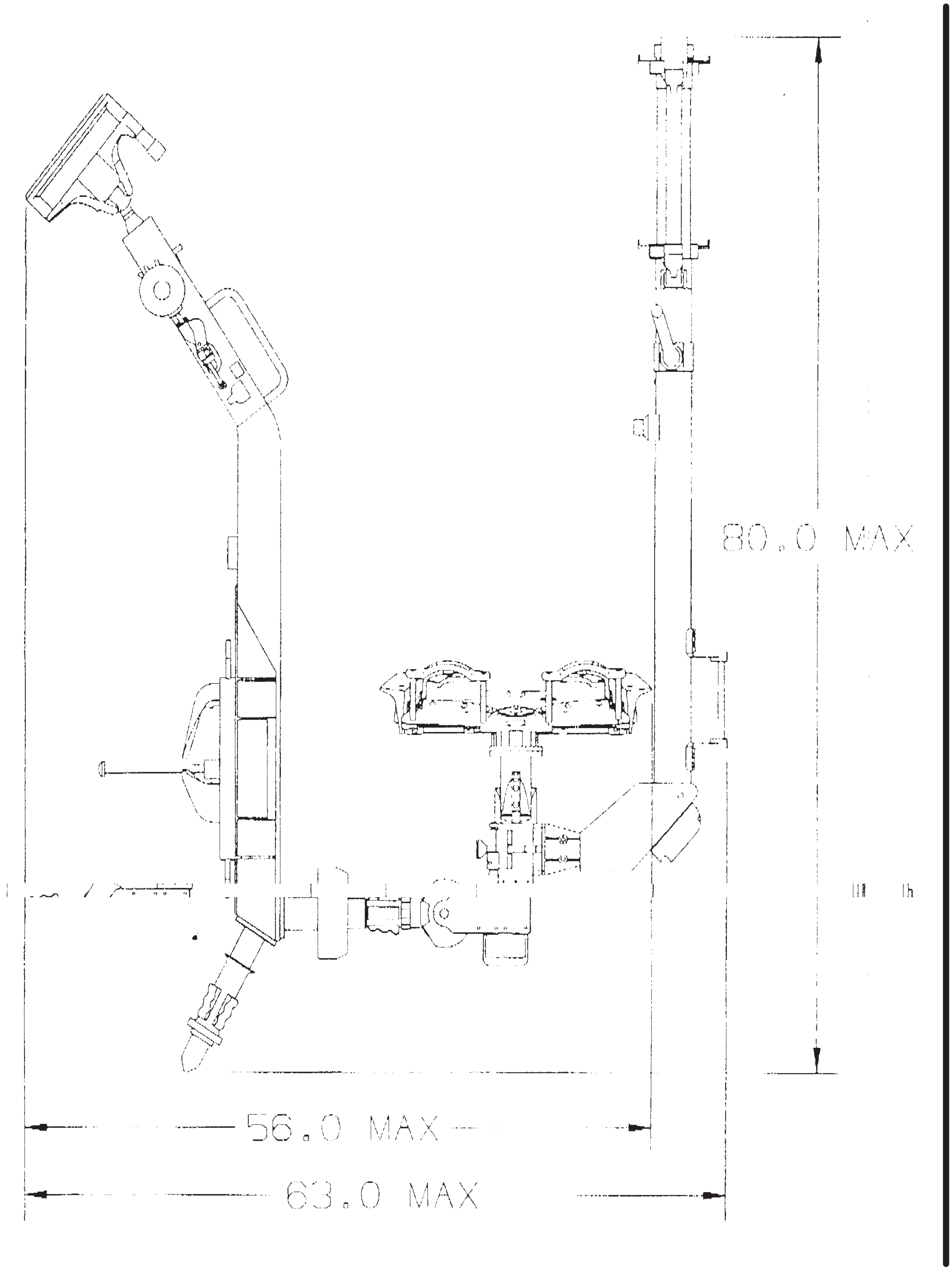


FIGURE E3.2.1.1–4 PWP STOWAGE ENVELOPE (PAGE 4 OF 4)

SECTION F3 SSMB LSA TO SSRMS INTERFACE

F3.0 REQUIREMENTS

F3.1 GENERAL

The SSRMS will interface with the SSMB Launch Support Assembly (LSA) via mechanical attachments and electrical connections. A Flight Support Equipment Grapple Fixture (FSEGF) and Flight Support Equipment (FSE) brackets will provide the physical interface. An FSEGF harness will provide electrical connections between the FSEGF and the Lab–S0 connector panel. A video signal converter (VSC) will be mounted on the SSRMS FSEGF to support video media conversion from copper to fiber optic. Section H defines VSC to SSMB interfaces.

F3.1.1 INTERFACE DESCRIPTION

The SSRMS to SSMB LSA interfaces consist of structural, mechanical, thermal, electrical and environmental interfaces via the FSEGF, the FSEGF harness, FSE brackets and FSE hardware. The FSEGF electrical interface consists of a harness to Lab–S0 connector panel for power, data, and video resources.

F3.1.2 COORDINATE SYSTEMS

The Space Station integrated stage configurations and elements will be in accordance with the coordinate systems defined in SSP 30219, Space Station Reference Coordinate Systems.

F3.1.3 SSMB INTERFACE FUNCTIONS

The SSMB LSA shall:
A. Provide mechanical and structural attachment of the SSRMS and associated FSE
B. Provide EVA access to interface attachments to support deployment
C. Provide EVA Tie–Down to fasten FSEGF harness during launch

The USL shall:
D. Provide a connector panel for the electrical interface
E. Provide utility distribution to the connector panel
F. Provide EVA access to connections to support deployment
G. Provide power distribution to the connector panel for SSRMS
H. Provide a PDGF local bus (PDGF LB) to the connector panel for SSRMS
I. Provide sync and control signal to the connector panel for SSRMS
J. Receive video signal via the connector panel for SSRMS

F3.1.4 SSRMS INTERFACE FUNCTIONS

The SSRMS shall :

A. Provide mechanical and structural attachment to the SSMB LSA via the FSEGF and FSE bracket.
B. Provide EVA access to interface attachments and connections to support deployment

The FSEGF harness shall:
C. Provide utility distribution to the USL connector panel
D. Receive power from the USL connector panel
E. Receive a PDGF local bus (PDGF LB) from the USL connector panel
F. Receive video sync and control signal from the USL connector panel
G. Provide video signal to the USL connector panel

F3.1.5 INTERFACE RESPONSIBILITIES

The interface hardware responsibilities will be as defined in Table F3.1.5–1.

F3.2 INTERFACE REQUIREMENTS

F3.2.1 SSMB INTERFACE REQUIREMENTS

F3.2.1.1 SSMB LSA ENVELOPES

a) The SSMB LSA shall accommodate the SSRMS launch configuration envelopes as defined in Figure F3.2.1.1–1.

b) The SSMB LSA shall provide an EVA access envelope around the FSEGF in accordance with SSP 50005, ISS Flight Crew Standard.

c) The SSMB LSA shall provide EVA accessibility to support the SSRMS deployment in accordance with SSP 50005.

F3.2.1.2 SSMB LSA MECHANICAL INTERFACE

a) The SSMB LSA shall provide a bolt hole pattern for mechanical interface to the SSRMS as defined in Figure F3.2.1.2–1.

b) The SSMB LSA shall support the bolts and shims for the FSEGF, the FSE brackets, SSRMS hinge end, and the SSRMS joint end interfaces.

c) The SSMB LSA shall provide EVA translation paths to support the deployment of the SSRMS in accordance with SSP 50005. The SSMB LSA shall provide EVA translation aids in accordance with SSP 30256:001, EVA Standard Interface Control Document.

F3.2.1.3 SSMB LSA STRUCTURAL INTERFACES

The SSMB LSA shall have a structural interface with the SSRMS launch package. This interface is characterized by interface loads to support launch, misalignments, and thermal contributions transmitted from the SSRMS FSEGFs, FSE brackets, hinge end, and joint end interface bolts to the SSMB LSA.

F3.2.1.3.1 STIFFNESS

The SSMB LSA shall provide a minimum stiffness as defined below:

	Rotation about Orbiter X–Axis
Heavy end bolts	2 x 10^6 Ft–Lb/Rad
Light end bolts	1 x 10^6 Ft–Lb/Rad
FSEGF bolts	2 x 10^6 Ft–Lb/Rad

F3.2.1.3.2 ON–ORBIT INTERFACE LOADS

During SSRMS operations from FSEGF, the SSMB LSA shall meet all performance requirements while being subject to the loads as defined in Table F3.2.1.3.2–1.

F3.2.1.3.3 DELETED

F3.2.1.3.4 LAUNCH LOADS

During launch, the SSMB LSA shall meet all performance requirements while being subjected to the loads as defined in Table F3.2.1.3.4–1.

F3.2.1.4 USL ELECTRICAL INTERFACE HARDWARE

a) The USL shall provide a connector panel for the FSEGF power, data, and video harnesses.

b) The USL shall support the tie down of the FSEGF harness to the USL connector panel.

F3.2.1.4.1 ELECTRICAL CONNECTORS

USL electrical connectors at the interface shall comply with the requirements of SSQ 21635, General Specifications for Connectors and Accessories, Electrical, Circular, Miniature, IVA/EVA/Robot Compatible, Space Quality.

F3.2.1.5 USL POWER INTERFACES

The USL shall provide power to the SSRMS via the FSEGF harness as defined in Figure F3.2.1.5–1

F3.2.1.5.1 SUPPLY POWER

The USL shall supply power to the SSRMS via FSEGF through the FSEGFSSRMS1LAB and FSEGFSSRMS2LAB power circuits.

F3.2.1.5.1.1 POWER QUALITY

The interface power quality shall be in accordance with SSP 30482, Volumes I and II, Interface B with a steady state voltage range as defined in Table F3.2.1.5.1.1–1.

F3.2.1.5.1.2 FAULT PROTECTION

The USL shall provide protection as shown in Table F3.2.1.5.1.1–1.

F3.2.1.5.2 DELETED

F3.2.1.5.3 ELECTRICAL CONNECTOR DEADFACING

The USL connector panel shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

F3.2.1.5.4 SHIELDING

USL cable shields shall be terminated to structure or chassis at each end.

F3.2.1.5.5 REDUNDANCY

The USL shall provide a prime and redundant SSRMS power feeds to the SSRMS via the FSEGF harness.

F3.2.1.6 USL C&DH INTERFACES

a) The USL shall provide a PDGF local bus (PDGF LB) to the FSEGF harness as shown in Figure F3.2.1.6–1.

b) The USL PDGF LB design shall be in accordance with SSQ 21655.

c) The USL shall provide the A channel of the PDGF LB and the B channel of the PDGF LB through separate connectors.

F3.2.1.6.1 PROVIDE OUTPUT AMPLITUDE

The SSMB shall provide a signal amplitude of at least 3.6 Volts, peak–to–peak, line–to–line, at the FSEGF harness interface for messages transmitted on the PDGF LB.

F3.2.1.6.2 MIL–STD–1553 BUS ADDRESSES

The MIL–STD–1553 bus addresses for the remote terminals on PDGF LB shall be as defined in Table D3.2.1.6.2–1.

F3.2.1.7 SSMB SYNC, CONTROL, AND VIDEO INTERFACES

a) The SSMB shall provide PFM sync, control, and video interfaces to the FSEGF harness as shown in Figure F3.2.1.5–1.

b) The SSMB shall provide three PFM video and two sync fiber optic lines to distribute sync and control signal to and to receive video signal from the SSRMS via FSEGF harness.

c) The SSMB fiber optic sync, control, and video interconnect cables shall comply with the requirements of SSQ 21654.

d) The sync and control signal transmitted across the interface shall include camera commands.

F3.2.1.7.1 SSMB VIDEO, SYNC, AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS

The SSMB shall transmit PFM sync and control signal and shall receive PFM video from the FSEGF harness with characteristics in accordance with **TBD.**

F3.2.1.7.2 SSMB SYNC AND CONTROL OPTICAL POWER

The SSMB shall transmit the sync and control to the truss mounted FSEGF harness with optical power levels which meet as a minimum the values specified in Table F3.2.1.7.2–1.

F3.2.1.7.3 SSMB VIDEO OPTICAL POWER

The SSMB shall receive the video signals from the FSEGF harness with optical power levels which meet as a minimum the values specified in Table F3.2.1.7.3–1

F3.2.1.8 SSMB LSA THERMAL INTERFACES

The LSA will provide a passive thermal interface to the FSEGF.

F3.2.1.9 ENVIRONMENTS

F3.2.1.9.1 ELECTROMAGNETIC EFFECTS

F3.2.1.9.1.1 ELECTROMAGNETIC COMPATIBILITY

The SSMB LSA and SSMB interface with the SSRMS shall meet the requirements of SSP 30243, Space Station Systems Requirements for Electromagnetic Compatibility.

F3.2.1.9.1.2 GROUNDING

The SSMB LSA and SSMB interface shall meet the requirements of SSP 30240, Space Station Grounding Requirements.

F3.2.1.9.1.3 BONDING

a) The SSMB LSA and SSMB structural/mechanical interface shall meet the requirements of SSP 30245, Space Station Electrical Bonding Requirements.

b) Bonding provisions at the interface shall satisfy a Class H and R bond in accordance with the above reference document.

F3.2.1.9.1.4 CABLE AND WIRE DESIGN

The SSMB cable and wire interface shall meet the requirements of SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility.

F3.2.1.9.1.5 DELETED

F3.2.1.9.1.6 DELETED

F3.2.2 SSRMS INTERFACE REQUIREMENTS

F3.2.2.1 SSRMS HARDWARE ENVELOPES

a) The SSRMS, the FSEGF, the FSE bracket and associated FSE hardware envelope shall be as defined in Figure F3.2.1.1–1.

b) The SSRMS FSE shall provide EVA accessibility in accordance with envelopes defined in EVA design requirements specified in SSP 50005, section 14.3.2.3.1.

F3.2.2.2 SSRMS MECHANICAL INTERFACE

a) The SSRMS shall provide FSE which mates the SSRMS to the SSMB LSA.

b) The SSRMS shall provide the bolts and shims for the FSEGF, FSE brackets, SSRMS hinge end, and the SSRMS joint end interfaces as defined in Figure F3.2.1.1–1.

F3.2.2.3 SSRMS STRUCTURAL INTERFACES

a) The SSRMS and associated FSE shall have a structural interface with the SSMB LSA provided bolt hole patterns.

b) This interface is characterized by interface loads due to launch, misalignments, and thermal contributions transmitted from the SSRMS FSEGFs, FSE brackets, hinge end, and joint end interface bolts to the SSMB LSA.

F3.2.2.3.1 DELETED

F3.2.2.3.2 ON–ORBIT INTERFACE LOADS

The FSEGF/SSRMS shall meet all performance requirements while being subject to the loads as defined in Table F3.2.1.3.2–1.

F3.2.2.3.3 DELETED

F3.2.2.3.4 LAUNCH LOADS

During launch, the SSRMS launch configuration shall meet all performance requirements while being subjected to the loads as defined in Table F3.2.1.3.4–1.

F3.2.2.4 SSRMS ELECTRICAL INTERFACE HARDWARE

a) The FSEGF shall provide the power, data, and video harnesses to the USL connector panel.

b) The FSEGF harness shall provide the capability to be tied down on the USL, and the SSMB LSA.

F3.2.2.4.1 ELECTRICAL CONNECTORS

FSEGF harness electrical connectors at the interface shall comply with the requirements of SSQ 21635, General Specifications for Connectors and Accessories, Electrical, Circular, Miniature, IVA/EVA/Robot Compatible, Space Quality.

F3.2.2.5 SSRMS POWER INTERFACES

a) The SSRMS via the FSEGF harness shall receive power from USL as defined in Figure F3.2.1.5–1.

b) The FSEGF harness shall not exceed 15 ft in length.

F3.2.2.5.1 RECEIVE POWER

a) The FSEGF shall provide the capability to receive power from the USL through the FSEGFSSRMS1LAB and FSEGFSSRMS2LAB power circuits.

b) The steady–state current drawn by the SSRMS on each circuit shall not exceed 17.5 Amps at 114 Vdc.

F3.2.2.5.1.1 POWER QUALITY

The interface power quality shall be in accordance with SSP 30482, Volumes I and II, Interface B with a steady state voltage range as defined in Table F3.2.1.5.1.1–1.

F3.2.2.5.1.2 FAULT PROTECTION

The USL will provide fault protection as shown in Table F3.2.1.5.1.1–1.

F3.2.2.5.2 ELECTRICAL CONNECTOR DEADFACING

The FSEGF harness shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

F3.2.2.5.3 SHIELDING

The FSEGF harness shields shall be terminated to structure or chassis at each end.

F3.2.2.5.4 REDUNDANCY

The SSRMS via FSEGF harness shall receive a prime and redundant SSRMS power feed from the USL connector panel.

F3.2.2.6 FSEGF C&DH INTERFACES

a) The FSEGF harness shall provide a Bus Coupler (BC) and in–line termination for the PDGF LB as shown in Figure F3.2.1.6–1.

b) The FSEGF harness local data bus design shall be in accordance with SSQ 21655.

c) The FSEGF harness shall receive the A channel of the PDGF LB and the B channel of the PDGF LB through separate connectors.

F3.2.2.6.1 PROVIDE OUTPUT AMPLITUDE

FSEGF harness shall provide a signal amplitude of at least 3.6 volts, peak–to–peak, line–to–line, at the SSMB interface for messages transmitted on the PDGF LB.

F3.2.2.6.2 MIL–STD–1553 DATA BUS ADDRESSES

The MIL–STD–1553 bus addresses for the Remote Terminals on PDGF LB shall be as defined in Table D3.2.1.6.2–1.

F3.2.2.7 SSRMS SYNC, CONTROL, AND VIDEO INTERFACES

a) The FSEGF harness shall provide PFM sync, control, and video interfaces with the USL as shown in Figure F3.2.1.5–1.

b) The FSEGF harness shall distribute sync and control signal to the SSRMS.

c) The FSEGF harness shall provide three video fiber optic lines to distribute video signals to the SSMB.

d) The video signal transmitted across the interface shall include the MSS camera telemetry.

e) The FSEGF harness fiber optic sync, control, and video interconnect cables shall comply with the requirements of SSQ 21654.

F3.2.2.7.1 SSRMS VIDEO SYNC AND CONTROL SIGNAL TRANSMISSION AND SIGNAL CHARACTERISTICS

The SSRMS FSEGF harness shall transmit PFM video signal characteristics and receive PFM sync and control signal characteristics in accordance with **TBD**.

F3.2.2.7.2 FSEGF SYNC AND CONTROL OPTICAL POWER

The FSEGF harness shall receive the sync and control signals with optical power levels which meet as a minimum the values specified in Table F3.2.1.7.2–1.

F3.2.2.7.3 FSEGF VIDEO OPTICAL POWER

The FSEGF harness shall transmit the video signals with optical power levels which meet as a minimum the values specified in Table F3.2.1.7.3–1

F3.2.2.8 FSEGF THERMAL INTERFACES

The FSEGF will provide a passive thermal interface to the LSA.

F3.2.2.9 ENVIRONMENTS

F3.2.2.9.1 ELECTROMAGNETIC EFFECTS

F3.2.2.9.1.1 ELECTROMAGNETIC COMPATIBILITY

The FSEGF harness and SSRMS interface with the SSMB LSA and USL shall meet the requirements of SSP 30243, Space Station Systems Requirements for Electromagnetic Compatibility.

F3.2.2.9.1.2 GROUNDING

The FSEGF and SSRMS harness interface shall meet the requirements of SSP 30240, Space Station Grounding Requirements.

F3.2.2.9.1.3 BONDING

a) The FSEGF harness and SSRMS structural/mechanical interface shall meet the requirements of SSP 30245, Space Station Electrical Bonding Requirements.

b) Bonding provisions at the interface shall satisfy a Class H and R bond in accordance with the above referenced document.

F3.2.2.9.1.4 CABLE AND WIRE DESIGN

The FSEGF harness cable and wire interface shall meet the requirements of SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility.

F3.2.2.9.1.5 ELECTROSTATIC DISCHARGE

The FSEGF harness interface shall meet the requirements of SSP 30243.

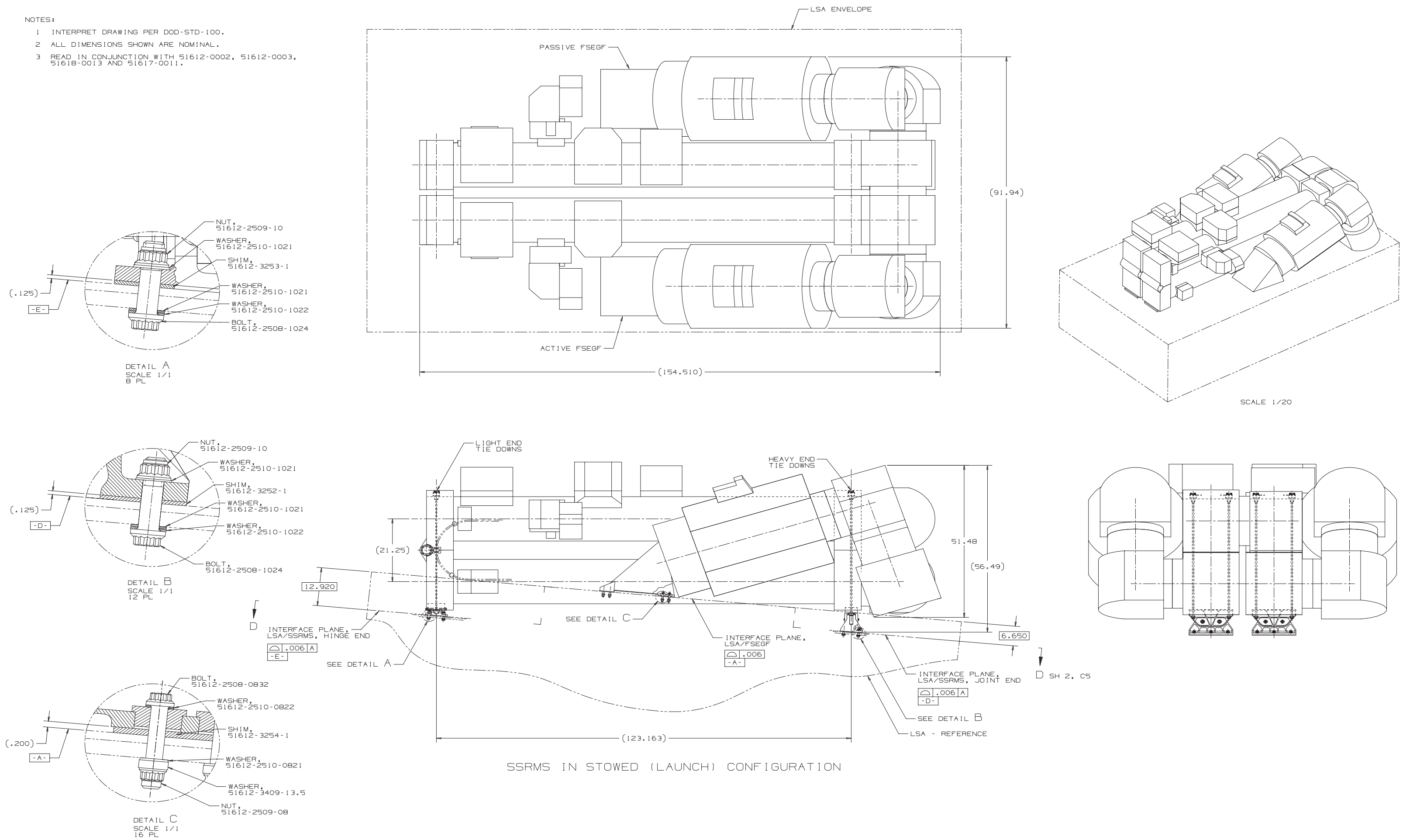
F3.2.2.9.1.6 CORONA

The FSEGF harness interface shall meet the requirements of SSP 30243.

TABLE F3.1.5–1 INTERFACE HARDWARE RESPONSIBILITIES

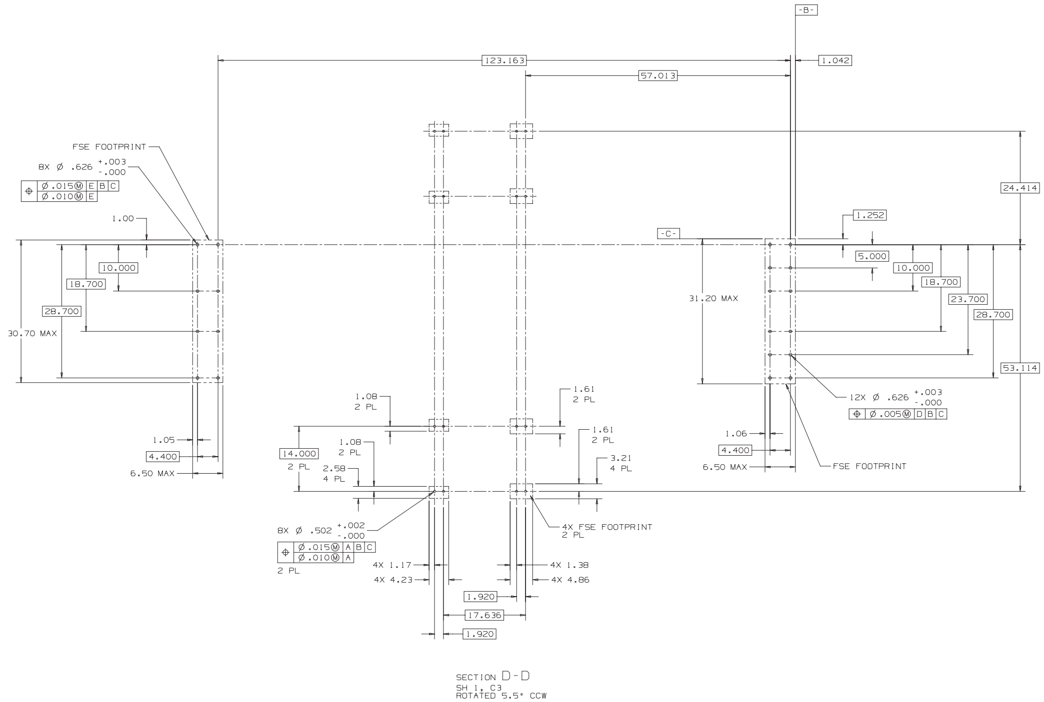
SSMB LSA to SSRMS INTERFACE	NASA	CSA
Structural/Mechanical		
– SSRMS LSA	X	
– SSRMS		X
– FSEGFs (two) and FSE brackets (four)		X
– Bolt Holes on SSRMS LSA (Hinge End)	X	
– Bolt Holes on SSRMS LSA (Joint End)	X	
– Bolt Holes on SSRMS LSA (FSEGFs)	X	
– Interface Bolts for SSRMS (Hinge End) 8 bolts total		X
– Interface Bolts for SSRMS (Joint End) 12 bolts total		X
– Interface Bolts for SSRMS (FSEGFs) 8 bolts/FSEGF		X
– Associated Shimming		X
Electrical (1)		
USL/S0 connector panel, terminating connectors	X	
FSEGF & VSC with harness		X
Terminating Connectors for FSEGF Harness	X	

1) The FSEGF is supplied with the harness. The VSC assembly is supplied as a part of the FSEGF harness. The VSC is physically located within the FSEGF.



Note: Reference SPAR drawing 51612–0037

FIGURE F3.2.1.1–1 SSRMS LAUNCH CONFIGURATION ENVELOPES

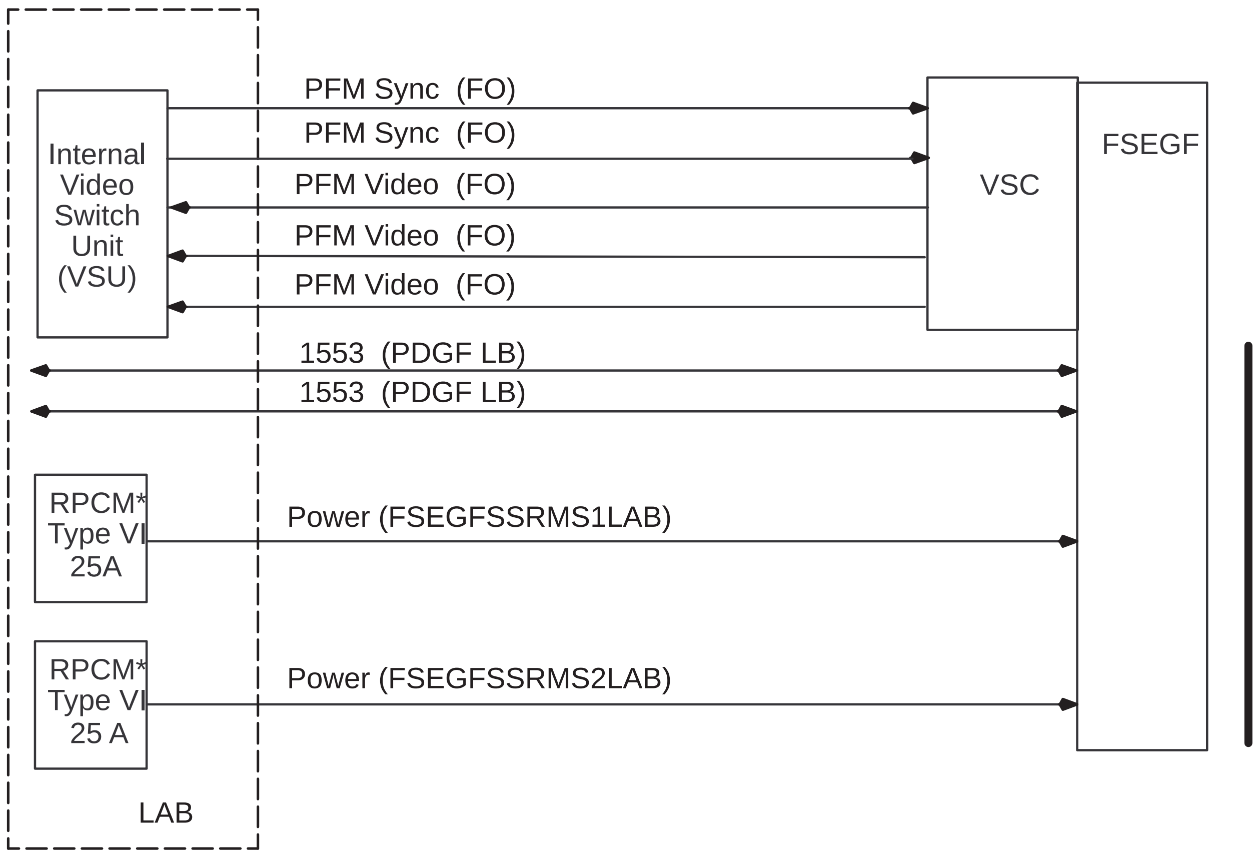


Note: Reference SPAR drawing 51612–0037

FIGURE F3.2.1.2–1 LSA BOLT HOLE PATTERN

TABLE F3.2.1.3.4–1 SSRMS TO SSMB LSA LAUNCH LOADS

	Maximum Loads			
Loads	AXIAL (lbs)	SHEAR (lbs)	TORSION (in–lbs)	BENDING (in–lbs)
Heavy end	13042	14509	1702	100803
Light end	4941	4011	9077	90648
FSEGF	5146	4463	37344	186516



Note: *Fault protection is equivalent with SSP 30263:002, RPCM Standard ICD.

FIGURE F3.2.1.5–1 USL TO FSEGF ELECTRICAL FUNCTION DIAGRAM

TABLE F3.2.1.3.2–1 FSEGF ASSEMBLY ON–ORBIT STATIC LIMIT LOADS

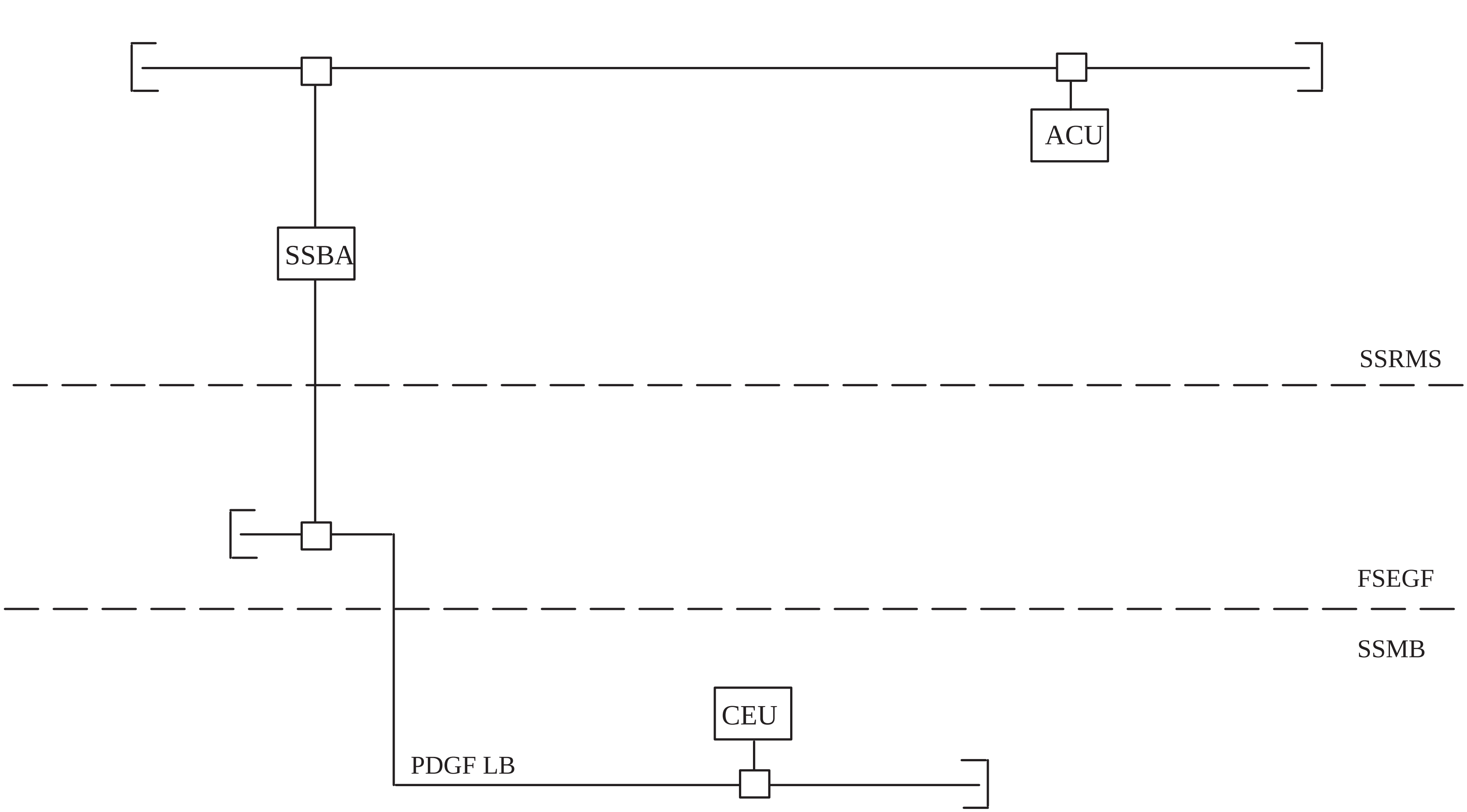
Case	Axial Force, X GFAS		Shear Force, Y GFAS Z GFAS plane		Torsion Moment, X GFAS		Bending Moment, YGFASZGFAS plane	
	N	lb	N	lb	N–m	lb–ft	N–m	lb–ft
1	1000	225	1000	225	3100	2288	3100	2288
2	220	50	220	50	4270	3483	4270	3483

Notes:
1. Only one axial/shear force and one torsion/bending moment act at the same time.
2. FSEGF Assembly is in latched condition.

TABLE F3.2.1.5.1.1–1 USL TO FSEGF ELECTRICAL INTERFACE PARAMETERS

Circuit Name	Interface V range (volts)	Operating Current (amps)	Overcurrent Protection
FSEGFSSRMS1LAB	114 to 126	0 to 17.5	Note 2 or Note 1
FSEGFSSRMS2LAB	114 to 126	0 to 17.5	Note 2 or Note 1

Notes:
1) Protection shall be equivalent with SSP 30263:002, Type II RPCM Standard ICD.
2) Protection shall be equivalent with SSP 30263:002, Type VI RPCM Standard ICD.
3) SSRMS operate from 113 volt DC minimum at the base LEE to FSEGF interface.



Legend
SSBA: SS Buffer Amplifier
Bus Coupler
Bus Termination
ACU: SSRMS Arm Control Unit
CEU: Control Electronics Unit

FIGURE F3.2.1.6–1 PDGF LB CONFIGURATION

TABLE F3.2.1.7.2–1 USL SYNC OPTICAL POWER

End to End Link Description		NASA 400 Series Connector Interface	NASA 300 Series Connector Interface	CSA 300 Series Connector Interface
Sync Source	Sync Destination	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)
Sync #2	FSEGF VSC	–17.4	–22.0	–22.0
Sync #1	FSEGF VSC	–17.4	–22.0	–22.0

Note: Maximum Optical Power Level will not exceed –10 dBm at the CSA interface.

TABLE F3.2.1.7.3–1 FSEGF HARNESS VIDEO OPTICAL POWER

End to End Link Description		CSA 300 Series Connector Interface	NASA 300 Series Connector Interface	NASA 400 Series Connector Interface
Video Source	Video Destination	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)	Minimum Optical Power at Interface Connector (dBm)
FSEGF VSC	VSU 2 Link 1	–14.7	–14.7	–16.4
FSEGF VSC	VSU 2 Link 2	–14.7	–14.7	–16.4
FSEGF VSC	VSU 1	–14.7	–14.7	–16.4

Note: Maximum Optical Power Level will not exceed –8 dBm at the CSA interface.

SECTION G3 AVU CCD TO RWS INTERFACE

G3.1 GENERAL

G3.1.1 INTERFACE DESCRIPTION

The Robotic Workstation provides structural, mechanical, power, and data interfaces for the Artificial Vision Unit (AVU) Cursor Control Device (CCD). Each Robotic Workstation (RWS) supports a single AVU CCD. The USL and Cupola provide environmental interfaces for the AVU CCD.

G3.1.2 COORDINATE SYSTEMS

The Space Station integrated stage configurations and elements will be in accordance with the coordinate systems as defined in SSP 30219, Space Station Reference Coordinate Systems.

G3.1.3 AVU CCD INTERFACE FUNCTIONS

The GFE AVU CCD will :

A. Provide mechanical and structural interfaces to the RWS

B. Provide connectors to support power and data distribution with the RWS

C. Provide a volumetric envelope to the RWS

D. Provide environmental interfaces to the USL and Cupola

G3.1.4 RWS INTERFACE FUNCTIONS

The RWS will :

A. Provide mechanical and structural attachments for the AVU CCD

B. Provide power and data utility distribution to the AVU CCD

C. Provide volumetric envelopes for the AVU CCD

D. Provide thermal interface for the AVU CCD

The USL will:

E. Provide environmental interfaces to the AVU CCD

The Cupola will:

F. Provide environmental interfaces to the AVU CCD

G3.1.5 INTERFACE RESPONSIBILITIES

The interface hardware responsibilities shall be as defined in Table G3.1.5–1.

G3.2 INTERFACE REQUIREMENTS

G3.2.1 AVU CCD INTERFACE REQUIREMENTS

G3.2.1.1 AVU CCD HARDWARE ENVELOPES

The AVU CCD shall provide a maximum envelope to the RWS as defined in Figure G3.2.1.1–1.

G3.2.1.1.1 MASS

AVU CCD mass shall not exceed 2.75 lbs. (1.25kg).

G3.2.1.2 AVU CCD MECHANICAL INTERFACES

The AVU CCD shall provide a mechanical interface to the RWS.

The AVU CCD shall be mounted on the RWS with the quick action buttons located on the right hand side of the trackball.

The AVU CCD axis of motion shall be as shown on Figure G3.2.1.1–1.

G3.2.1.3 AVU CCD STRUCTURAL INTERFACES

The AVU CCD shall provide a structural interface to the RWS.

G3.2.1.4 ELECTRICAL CONNECTORS

The AVU CCD shall provide a circular connector with externally mounted flange in accordance with MIL–C–38999, Series III.

G3.2.1.5 POWER INTERFACES

The AVU CCD shall receive + 5 Vdc ± 5 percent power from the RWS over the full available current range.

G3.2.1.5.1 POWER SUPPLY

The AVU CCD shall not exceed a maximum consumption of 1.5 Watts of power.

G3.2.1.5.2 FAULT PROTECTION – N/A

G3.2.1.5.3 GROUNDING

The AVU CCD grounding interface shall meet the requirements as specified in SSP 30240, Space Station Grounding Requirements, section 3.0, Requirements.

G3.2.1.5.4 BONDING

The AVU CCD interface shall satisfy a Class H bond in accordance with SSP 30245, section 3.0.

G3.2.1.5.5 SHIELDING

The AVU CCD shields shall be terminated to structure or chassis at each end.

G3.2.1.6 DATA INTERFACES

The AVU Cursor Control Device shall provide a data interface to the RWS in accordance with TIA/EIA–422.

G3.2.1.7 VIDEO INTERFACES – N/A

G3.2.1.8 THERMAL CONTROL SYSTEM INTERFACE CHARACTERISTICS – N/A

G3.2.1.9 ENVIRONMENTAL INTERFACES

The AVU CCD shall be designed to meet the environmental conditions described in the following paragraphs.

G3.2.1.9.1 THERMAL (NON–OPERATING)

The AVU CCD shall meet all performance requirements after being exposed to steady state temperatures ranging from +40°F to +150°F (+4.4 °C to +65.6°C).

G3.2.1.9.2 THERMAL (OPERATING)

During operational periods, the AVU CCD shall meet all performance requirements while being exposed to air temperatures of +65°F to +85°F (+18.3°C to +29.4°C) and an effective atmosphere velocity within the range of 15 to 40 feet per minute with a minimum velocity of 7 feet per minute. The AVU CCD shall meet all performance requirements while being exposed to a maximum mounting bracket temperature of 40°C.

G3.2.1.9.3 COLDPLATE TEMPERATURE – N/A

G3.2.1.9.4 HEAT DISSIPATION

The total conducted heat dissipation to the RWS External Rack Components for the AVU CCD shall be 1.5 Watts or less.

G3.2.1.9.4.1 COLDPLATE INTERFACES – N/A

G3.2.1.9.4.2 RACK AIR – N/A

G3.2.1.9.5 PRESSURE (NON–OPERATING)

The AVU CCD shall meet all performance requirements after being exposed to flight module ambient pressures of 13.5 to 15.2 psia.

G3.2.1.9.6 PRESSURE (OPERATING)

During operational periods, the AVU CCD shall meet all performance requirements while being exposed to flight module ambient pressures of 13.9 to 15.2 psia.

G3.2.1.9.7 DEPRESSURIZATION/REPRESSURIZATION (NON–OPERATING)

In the event of depressurization and repressurization, AVU CCD shall meet all performance requirements after exposure to 24 hours at hard vacuum (2.0×10^{-4} psia). For time periods of longer than 24 hours at hard vacuum, the AVU CCD shall be permitted to be removed and replaced to re–establish normal performance following a depressurization and repressurization event. The AVU CCD shall meet all performance requirements after being exposed to flight module depressurization and repressurization conditions as defined below:

– Depressurization rate as defined in Figure G3.2.1.9.7–1

– Repressurization rate of 2.0 psi/min.

The air temperature range is dependent on equipment design and location and is predicted by analysis. In order to perform the analysis the following parameters shall be used.

Pressure (psia)	Air Temperature (°F) (1) (2)
15.2 to 9.0	+75 to +5
9.0 to 5.0	+5 to –67
5.0 to 2.0×10^{-4}	–

(1) Air temperature based on isentropic expansion of dry air with an initial temperature of 75°F. They are presented as an aid for analysis and are considered to be worst case.

(2) The radiative environment temperature range during depressurization is +40°F to +75°F.

G3.2.1.9.8 HUMIDITY (NON–OPERATING)

The AVU CCD shall meet all performance requirements after being exposed to an ambient environment ranging from 0 to 100 percent relative humidity.

G3.2.1.9.9 HUMIDITY (OPERATING)

During operational periods, the AVU CCD shall meet all performance requirements while being exposed to 25 to 70 percent relative humidity.

G3.2.1.9.10 ACCELERATION (NON–OPERATING)

The AVU CCD shall operate after exposure to the low frequency launch accelerations specified in Table C3.2.2.9.12.1–1. (Note: The AVU CCD will be located in a stowage drawer for launch)

G3.2.1.9.11 ACCELERATION (OPERATING)

During operational periods, the AVU CCD shall meet all performance requirements while being exposed to accelerations of 0.2 g's in any direction. This acceleration shall be combined concurrently with on–orbit vibration per Table C3.2.2.9.14–1, one axis at a time.

G3.2.1.9.12 VIBRATION (NON–OPERATING)

Tthe AVU CCD shall operate after exposure to the random vibration environment specified in Table C3.2.2.9.13–1. (Note: The AVU CCD will be located in a stowage drawer for launch)

G3.2.1.9.13 VIBRATION (OPERATING)

During operational periods, the AVU CCD shall meet all performance requirements while being exposed to the vibrations shown in Table C3.2.2.9.14–1.

G3.2.1.9.14 ACOUSTIC ENVIRONMENT (NON–OPERATING) – N/A

G3.2.1.9.15 ACOUSTIC ENVIRONMENT (OPERATING)

During operational periods, the AVU CCD shall meet all performance requirements while being exposed to an NC–50 noise curve as defined in Figure C3.2.2.9.16–1.

G3.2.1.9.16 CREW LOADS

NA

G3.2.1.9.17 ELECTROMAGNETIC COMPATIBILITY

The AVU CCD shall be designed to be electromagnetically compatible with all other interfacing equipment and components. AVU CCD shall meet the requirements as specified in SSP 30243, Space Station System Requirements for EMC, section 3.0, Requirements.

G3.2.1.9.18 ELECTROMAGNETIC INTERFERENCE (EMI)

The AVU CCD shall be designed to meet the requirements as specified in SSP 30237, Space Station Electromagnetic Emission and Susceptibility Requirements for Electromagnetic Compatibility, section 3.0, Requirements, and SSP 30238, Space Station Electromagnetic Techniques, section 3.0, Requirements.

G3.2.1.9.19 TOTAL DOSE IONIZING RADIATION

The AVU CCD shall not exhibit any malfunction or degradation of performance beyond tolerances for a total ionizing radiation dose of 2.2 kRad (Si) over 10 years.

G3.2.1.9.20 SINGLE EVENT EFFECTS (SEE) IONIZING RADIATION

The AVU CCD shall meet the SEE environmental, design and test requirements as specified in SSP 30512 and SSP 30513.

G3.2.1.10 SOFTWARE INTERFACES – N/A

G3.2.2 RWS INTERFACE REQUIREMENTS

G3.2.2.1 HARDWARE ENVELOPES

The RWS shall accommodate the AVU CCD envelope defined in Figure G3.2.1.1–1. The RWS shall mount the AVU CCD with the quick action buttons located on the right hand side of the trackball.

G3.2.2.2 MECHANICAL INTERFACES

The RWS shall provide for mechanical attachment of the AVU CCD.

G3.2.2.3 STRUCTURAL INTERFACE

The RWS shall provide load bearing structural support at the AVU CCD interfaces to support 125 lbf crew loads applied to the AVU CCD.

G3.2.2.4 ELECTRICAL CONNECTORS

The RWS cable harness shall provide a connector at the AVU CCD interface in accordance with MIL–C–38999, Series III.

G3.2.2.5 POWER INTERFACES

The RWS shall provide + 5 Vdc ± 5 percent power to the AVU CCD over the full available current range.

G3.2.2.5.1 POWER SUPPLY

The RWS shall supply up to 1.5 Watts of power to the AVU CCD.

G3.2.2.5.2 FAULT PROTECTION

The RWS shall provide overcurrent protection to the AVU CCD. The RWS overcurrent curcuit shall trip off as follows:

+5V Output Current	+5V Output State
<0.345 Amps	On
0.345 Amps to 1.0 Amps	On or Off
>1.0 Amps	Off

Note: The trip off time shall not exceed 10 millisecs.

G3.2.2.5.3 GROUNDING

The RWS shall meet the grounding requirements as specified in SSP 30240, section 3.0, Requirements at the AVU CCD interface.

G3.2.2.5.4 BONDING

The RWS shall satisfy a Class H bond at the AVU CCD interface in accordance with SSP 30245, section 3.0, Requirements.

G3.2.2.5.5 SHIELDING

The RWS shields shall be terminated to structure or chassis at each end.

G3.2.2.6 RWS DATA INTERFACES

The RWS shall provide a unidirectional data interface to the AVU CCD in accordance with TIA/EIA–422. The Cupola design at the TIA/EIA–422 interface shall be in accordance with SSQ 21655, section 3.0, Requirements.

G3.2.2.7 VIDEO INTERFACES – N/A

G3.2.2.8 THERMAL CONTROL SYSTEM INTERFACES – N/A

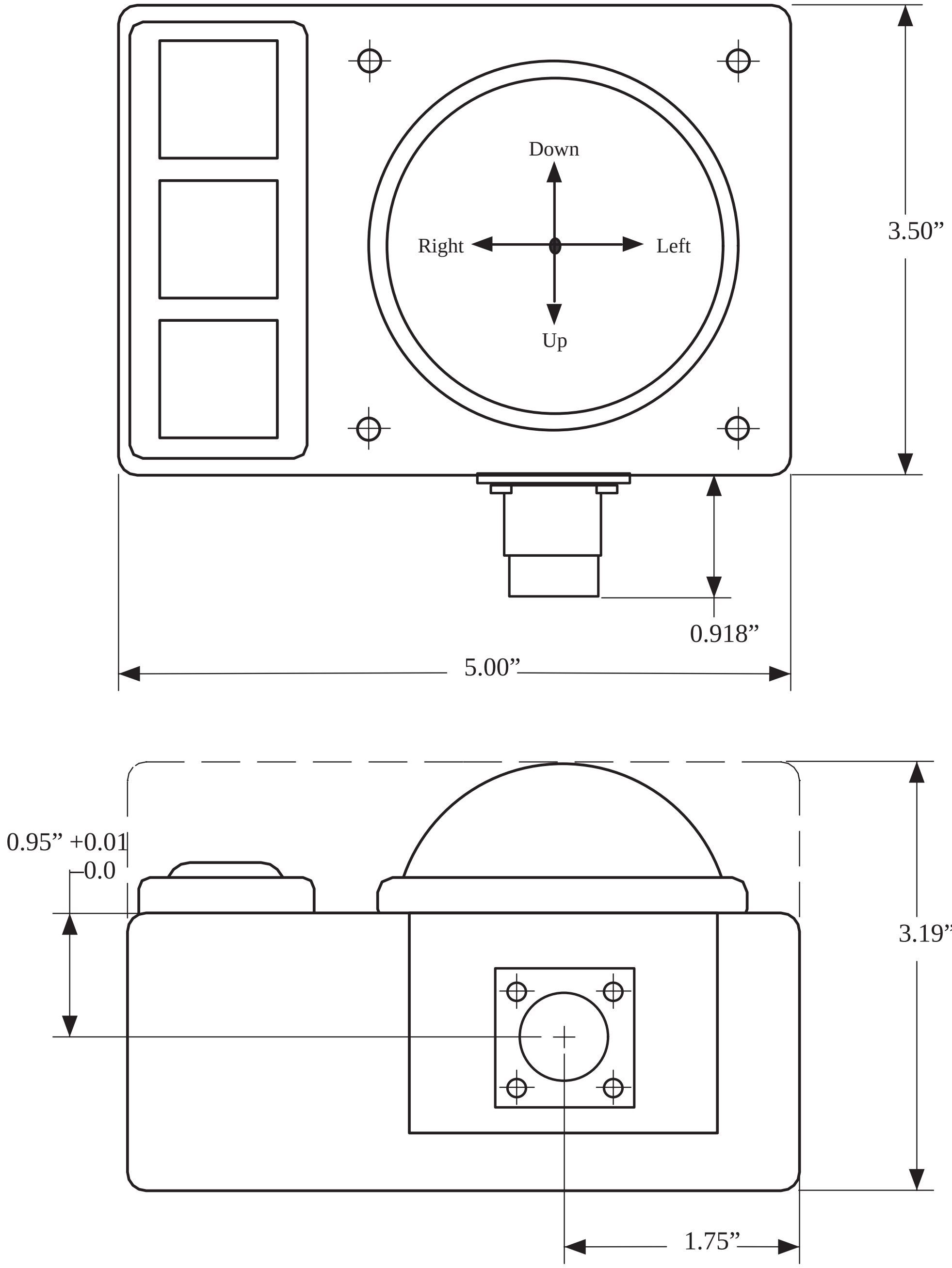
G3.2.2.9 ENVIRONMENTAL INTERFACES

The RWS shall limit the AVU CCD mounting bracket temperature to a maximum of 40°C. The RWS External Rack Components shall accommodate up to 1.5 Watts of conducted heat dissipation from the AVU CCD.

G3.2.2.10 SOFTWARE INTERFACES – N/A

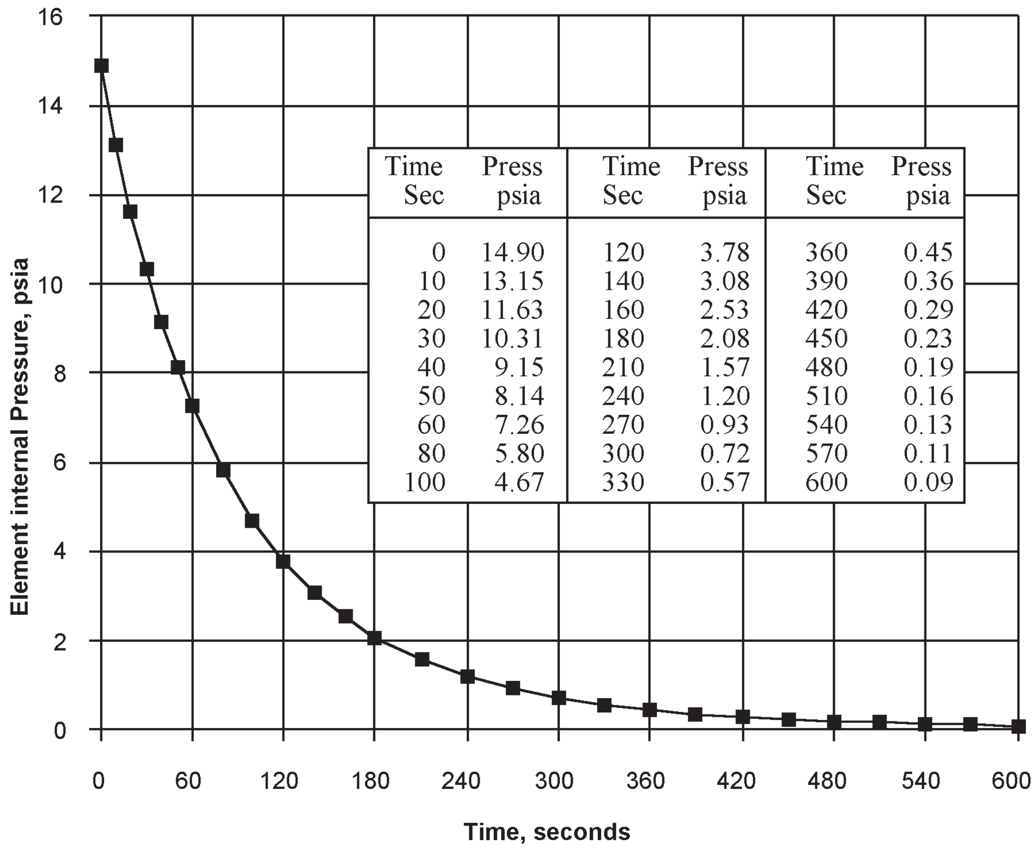
TABLE G3.1.5–1 RWS TO AVU CCD INTERFACE RESPONSIBILITIES

RWS/AVU CCD Interface	NASA	CSA
AVU CCD		X
Interconnecting cables to the AVU CCD	X	
Mechanical attachments to the AVU CCD	X	
RWS mounting structure for the AVU CCD	X	
USL	X	
Cupola	X	



Note: Up, down, left and right axis show motion of trackball that corresponds to cursor motion on RWS monitors.

FIGURE G3.2.1.1–1 AVU CCD VOLUMETRIC ENVELOPE



Time Sec	Press psia	Time Sec	Press psia	Time Sec	Press psia
0	14.90	120	3.78	360	0.45
10	13.15	140	3.08	390	0.36
20	11.63	160	2.53	420	0.29
30	10.31	180	2.08	450	0.23
40	9.15	210	1.57	480	0.19
50	8.14	240	1.20	510	0.16
60	7.26	270	0.93	540	0.13
80	5.80	300	0.72	570	0.11
100	4.67	330	0.57	600	0.09

FIGURE G3.2.1.9.7–1 PRESSURIZED ELEMENT DEPRESSURIZATION PROFILE

SECTION H3 SSMB TO VSC INTERFACE

H3.0 REQUIREMENTS

H3.1 GENERAL

A video signal converter (VSC) will be mounted on the Truss to support video media conversion (fiber optic to copper and copper to fiber optic) of MSS video and sync. Also, a VSC will be mounted near PDGFs used for relocated/stand–alone SSRMS operations on a module to support video media conversion.

H3.1.1 INTERFACE DESCRIPTION

The SSMB to VSC interfaces consist of structural, mechanical, thermal, environmental, power, and video interfaces. The VSC does not support MIL–STD–1553 data bus interfaces.

H3.1.2 COORDINATE SYSTEMS

The Space Station integrated stage configurations and elements will be in accordance with the coordinate systems defined in SSP 30219, Space Station Reference Coordinate Systems.

H3.1.3 SSMB INTERFACE FUNCTIONS

The SSMB shall :

A. Provide power distribution to the VSC
B. Circuit protect power to the VSC
C. Control the power supply to the VSC
D. Provide PFM fiber optic sync and control interface to the VSC from the VSW(E)
E. Receive PFM fiber optic video from the VSC at the VSW(E)
F. Receive data from Truss mounted VSCs for temperature monitoring
G. Provide EVA access to interface attachments and connections
H. Provide mechanical and structural attachments to the VSC soft dock plate
I. Receive PFM copper sync and control interface from the VSC
J. Provide PFM copper video to the VSC
K. Provide thermal control to the VSC (truss mounted VSC)
L. Provide thermal interface to the VSC bracket (module mounted VSC)

H3.1.4 VSC INTERFACE FUNCTIONS

The VSC shall :

A. Provide mechanical and structural attachments to the SSMB
B. Provide temperature monitoring interface to the SSMB
C. Receive power from the SSMB
D. Receive PFM fiber optic sync and control from the VSW(E)

E. Provide PFM fiber optic video to the VSW(E)
F. Receive PFM copper video from the SSMB
G. Provide PFM copper sync and control to the SSMB

H3.1.5 INTERFACE RESPONSIBILITIES

The interface hardware responsibilities will be as defined in Table H3.1.5–1.

H3.2 INTERFACE REQUIREMENTS

H3.2.1 SSMB ASSEMBLY INTERFACE REQUIREMENTS

H3.2.1.1 SSMB ASSEMBLY ENVELOPES

a) The SSMB shall accommodate on the modules a maximum VSC ORU assembly (includes ORU, micro fitting, and connectors) and VSC bracket envelope of 12” (w) x 12.5” (d) x 6.1” (h).

b) The SSMB shall accommodate on the truss a maximum VSC ORU assembly (includes ORU, micro fitting, and connectors) envelope of 12” (w) x 12.5” (d) x 5” (h).

H3.2.1.2 SSMB MECHANICAL INTERFACE

a) The SSMB modules shall mount the VSC ORU and VSC bracket.

b) The SSMB Truss shall provide a mounting area to accommodate the VSC ORU installation hardware.

c) The SSMB shall provide an EVA translation path to the VSC in accordance with SSP 50005, ISS Flight Crew Standard.

d) The SSMB shall provide attachment mechanisms in accordance with SSP 50005.

e) The EVA translation aids shall be in accordance with SSP 30256:001, EVA Standard Interface Control Document.

H3.2.1.3 SSMB STRUCTURAL INTERFACES

The on–orbit EVA torque required to fasten and unfasten the VSC shall be within 9 ft–lb minimum to 13 ft–lb maximum.

H3.2.1.4 SSMB ELECTRICAL INTERFACE HARDWARE

The SSMB electrical connectors at the interface shall comply with the requirements of SSQ 21635, General Specifications for Connectors and Accessories, Electrical, Circular, Miniature, IVA/EVA/Robot Compatible, Space Quality.

H3.2.1.5 SSMB POWER INTERFACES

a) The SSMB shall supply power to the truss mounted VSCs as defined in Figure H3.2.1.5–1.

b) The SSMB shall supply power to the module VSC as defined in Figure H3.2.1.5–2.

c) The SSMB shall be capable of supplying heater power as defined in Table H3.2.1.5–1 to the truss mounted VSC equipped with a 470 ± 5% ohms heater.

H3.2.1.5.1 SSMB POWER INTERFACE CHARACTERISTICS

The SSMB shall provide power to the VSC in accordance with Table H3.2.1.5–1.

H3.2.1.5.1.1 POWER QUALITY

The SSMB power interface characteristics shall be in accordance with power quality interface type C as defined in SSP 30482, Volumes I and II.

H3.2.1.5.2 FAULT PROTECTION

The SSMB shall provide fault protection in accordance with Table H3.2.1.5–1.

H3.2.1.5.3 ELECTRICAL CONNECTOR DEADFACING

The SSMB shall comply with the electrical connector deadfacing requirements as defined in Figure A3.2.1.5.4–1.

H3.2.1.5.4 SHIELDING

The SSMB harness shields shall be terminated to structure or chassis at each end, per SSP 30240.

H3.2.1.5.5 REDUNDANCY

a) The SSMB shall provide a redundant power feed to the VSC.

b) The SSMB shall provide a redundant heater power feed to the truss mounted VSC.

H3.2.1.6 RTD INTERFACE

a) The SSMB shall monitor one resistive temperature device (RTD) in each truss mounted VSC using SSMB MDMs.

b) Truss mounted VSC temperature shall be measured with a two wire RTD using the Low Level Analog Card (LLA) of an SSMB MDM.

c) The ice point (0°C) resistance of the RTD shall be 100 ohms.

d) When configured for temperature measurements, the SSMB LLA shall provide a 1.0 mA +/– 0.3% current loop source between the pair of input pins, and shall measure the voltage drop.

H3.2.1.7 SSMB SYNC, CONTROL, AND VIDEO INTERFACES

a) The SSMB shall provide two PFM fiber optic sync interfaces to the VSC.

b) The SSMB shall receive three PFM fiber optic video interfaces from the VSC.

c) The SSMB shall receive two PFM copper sync interfaces from the VSC.

d) The SSMB shall provide three PFM copper video interfaces to the VSC.

H3.2.1.7.1 SSMB FIBER OPTIC SYNC, CONTROL AND VIDEO INTERFACES

The SSMB fiber optic sync, control, and video interconnect cable shall comply with the requirements of SSQ 21654.

H3.2.1.7.1.1 SSMB SYNC AND CONTROL SIGNAL CHARACTERISTICS

The SSMB shall distribute pulse frequency modulated (PFM) sync and control signals to the VSC in accordance with **TBD**.

H3.2.1.7.1.2 SSMB SYNC AND CONTROL OPTICAL POWER

The SSMB shall transmit the PFM sync and control to the VSC with optical power levels which meet as a minimum the values specified in Table H3.2.1.7.1.2–1.

H3.2.1.7.1.3 SSMB VIDEO SIGNAL CHARACTERISTICS

The SSMB shall receive a pulse frequency modulated (PFM) video signal from the VSC in accordance with **TBD.**

H3.2.1.7.1.4 SSMB VIDEO OPTICAL POWER

The SSMB shall receive the PFM video signals from the VSC with optical power levels which meet as a minimum the values specified in Table H3.2.1.7.1.4–1.

H3.2.1.7.2 SSMB COPPER SYNC, CONTROL AND VIDEO INTERFACES

a) The SSMB copper sync, control, and video interconnect cable shall comply with the requirements of SSQ 21653.

b) The SSMB shall receive PFM copper sync and control from and transmit PFM copper video to the VSC in accordance with **TBD**.

H3.2.1.8 SSMB THERMAL INTERFACES

H3.2.1.8.1 VSC ORU TO TRUSS MOUNTING BRACKET THERMAL INTERFACES

a) During VSC non–operating conditions, the SSMB shall maintain the temperature of the VSC ORU at the structural interface between the VSC ORU and the SSMB provided truss mounting bracket, shown in Figure H3.2.1.8.1–1, within the range of –50 Deg. C to +85 Deg. C.

b) During VSC operating conditions, the SSMB shall maintain the temperature of the VSC ORU at the structural interface between the VSC ORU and the SSMB provided truss mounting bracket, shown in Figure H3.2.1.8.1–1, within the range of –30 Deg. C to +55 Deg. C.

c) The VSC ORU to the SSMB provided truss mounting bracket thermal conductance will be no less than 5 Watts/Deg. C and no greater than 10 Watts/Deg. C.

d) The VSC heater control set points will have the following characteristics:

i) Set point ON at –25 Deg. C, OFF at –20 Deg. C

ii) Set point accuracy ±3 Deg. C

iii) Hysteresis 5 Deg. C

iv) Hysteresis accuracy ±2 Deg. C

H3.2.1.8.2 VSC ORU TO MODULE MOUNTING BRACKET THERMAL INTERFACES

a) During VSC non–operating conditions, the SSMB shall maintain the temperature of the VSC ORU at the structural interface between the VSC ORU and the VSC bracket (Adapter Plate) as shown in Figure H3.2.1.8.2–1, within the range of **TBR** (–50 Deg. C to +85 Deg. C).

b) During VSC operating conditions, the SSMB shall maintain the temperature of the VSC ORU at the structural interface between the VSC ORU and the VSC bracket (Adapter Plate) as shown in Figure H3.2.1.8.2–1, within the range of **TBR** (–30 Deg. C to +55 Deg. C).

c) The SSMB shall provide a VSC bracket (adapter plate) to module mounting bracket thermal conductance of no less than **TBR** (6 Watts/Deg. C).

H3.2.1.9 ENVIRONMENTS

H3.2.1.9.1 ELECTROMAGNETIC EFFECTS

H3.2.1.9.1.1 ELECTROMAGNETIC COMPATIBILITY

The SSMB interface with the VSC shall meet the applicable requirements of SSP 30243, Space Station Systems Requirements for Electromagnetic Compatibility.

H3.2.1.9.1.2 GROUNDING

The SSMB interface shall meet the applicable requirements of SSP 30240, Space Station Grounding Requirements.

H3.2.1.9.1.3 BONDING

a) The SSMB structural/mechanical interface shall meet the applicable requirements of SSP 30245, Space Station Electrical Bonding Requirements.

b) Bonding provisions at the interface shall satisfy a Class H and R bond in accordance with the above reference document.

H3.2.1.9.1.4 CABLE AND WIRE DESIGN

The SSMB to VSC interface shall meet the requirements of SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility.

H3.2.1.9.1.5 ELECTROSTATIC DISCHARGE

The SSMB interface shall meet the electrostatic discharge requirements of SSP 30243.

H3.2.1.9.1.6 CORONA

The SSMB interface shall meet the corona requirements of SSP 30243.

H3.2.1.9.2 LAUNCH LOADS

The SSMB interface to the truss mounted VSC shall support applied launch loads defined below:

	X axis	Y axis	Z axis
Case 1	40g	10g	10g
Case 2	10g	40g	10g
Case 3	10g	10g	40g

H3.2.2 VSC INTERFACE REQUIREMENTS

H3.2.2.1 VSC HARDWARE ENVELOPES

a) The maximum envelope of the VSC ORU assembly (including ORU, micro fitting, and connectors) shall be 12” (w) x 12.5” (d) x 5” (h) for the truss mounted application.

b) The maximum envelope of the VSC ORU assembly (including ORU, micro fitting, and connectors) and VSC bracket shall be 12” (w) x 12.5” (d) x 6.1” (h) for the module mounted application.

H3.2.2.2 VSC MECHANICAL INTERFACE

a) The VSC bracket shall mount to the SSMB module mounting bracket.

b) The VSC ORU shall mount to the SSMB truss mounting bracket.

c) The VSC shall provide attachment mechanisms in accordance with SSP 50005.

H3.2.2.2.1 VSC MASS

a) The mass of Truss mounted VSC ORU assembly (including ORU, micro fitting, and connectors) shall not exceed 13.0 lbs.

b) The mass of Module mounted VSC ORU assembly (including ORU, micro fitting, and connectors) and VSC bracket shall not exceed 14.6 lbs.

H3.2.2.3 VSC STRUCTURAL INTERFACES

a) The VSC shall be tied down to either the VSC bracket or the truss mounting bracket using a Micro Interface.

b) The on–orbit EVA torque required to fasten the VSC shall be within 9 ft–lb minimum to 13 ft–lb maximum.

H3.2.2.4 VSC ELECTRICAL INTERFACE HARDWARE

The VSC electrical connectors at the interface shall comply with the requirements of SSQ 21635.

H3.2.2.5 VSC POWER INTERFACES

a) The truss mounted VSC shall receive power from the SSMB as defined in Figure H3.2.1.5–1.

b) The module mounted VSCs shall receive power from the SSMB as defined in Figure H3.2.1.5–2.

c) The truss mounted VSC heater size shall be 470 $\pm$ 5% ohms resistance.

H3.2.2.5.1 POWER INTERFACE CHARACTERISTICS

The VSC shall receive power from the SSMB in accordance with Table H3.2.1.5–1.

H3.2.2.5.1.1 POWER QUALITY

The VSC power interface characteristics shall be in accordance with power quality interface type C as defined in SSP 30482, Volumes I and II.

H3.2.2.5.2 DELETED

H3.2.2.5.3 SHIELDING

The VSC shields shall be terminated to structure or chassis at each end per SSP 30240.

H3.2.2.5.4 REDUNDANCY

a) The VSC shall receive a redundant power feed from the SSMB.

b) The truss mounted VSC shall receive a redundant heater power feed from the SSMB truss.

H3.2.2.6 RTD INTERFACE

a) For the purpose of monitoring the VSC temperature, each truss VSC shall provide one RTD that will interface with the SSMB MDM.

b) Truss mounted VSC temperature shall be measured with a two wire RTD using the Low Level Analog Card (LLA) of an SSMB MDM.

c) The ice point (0°C) resistance of the RTD shall be 100 ohms.

d) When configured for temperature measurements, the SSMB LLA shall provide a 1.0mA +/–3% current loop source between the pair of input pins, and shall measure the voltage drop.

H3.2.2.7 VSC SYNC, CONTROL, AND VIDEO INTERFACES

a) The VSC shall receive two PFM fiber optic sync interfaces from the SSMB.

b) The VSC shall provide three PFM fiber optic video interfaces to the SSMB.

c) The VSC shall provide two PFM copper sync interfaces to the SSMB.

d) The VSC shall receive three PFM copper video interfaces from the SSMB.

H3.2.2.7.1 VSC FIBER OPTIC SYNC, CONTROL AND VIDEO INTERFACES

The VSC sync, control, and video interconnect cables shall comply with the requirements of SSQ 21654.

H3.2.2.7.1.1 VSC SYNC AND CONTROL SIGNAL CHARACTERISTICS

The VSC shall receive pulse frequency modulated (PFM) sync and control signals from the SSMB in accordance with **TBD**.

H3.2.2.7.1.2 VSC SYNC AND CONTROL OPTICAL POWER

The VSC shall transmit the PFM sync and control signals with optical power levels which meet as a minimum the values specified in Table H3.2.1.7.1.2–1.

H3.2.2.7.1.3 VSC VIDEO SIGNAL CHARACTERISTICS

The VSC shall distribute a pulse frequency modulated (PFM) video signal to SSMB in accordance with **TBD**.

H3.2.2.7.1.4 VSC VIDEO OPTICAL POWER

The VSC shall transmit PFM video signals with optical power levels which meet as a minimum the values specified in Table H3.2.1.7.1.4–1.

H3.2.2.7.2 VSC COPPER SYNC, CONTROL AND VIDEO INTERFACES

The VSC shall receive PFM copper video signals from and transmit PFM copper sync and control signals to the SSMB in accordance with **TBD**.

H3.2.2.8 VSC THERMAL INTERFACES

H3.2.2.8.1 VSC ORU TO TRUSS MOUNTING BRACKET THERMAL INTERFACES

a) The VSC non–operating temperature limits at the VSC ORU, shown in Figure H3.2.1.8.1–1, shall be within the range of –50 Deg. C to + 85 Deg. C.

b) The VSC operating temperature limits at the VSC ORU, shown in Figure H3.2.1.8.1–1, shall be within the range of –30 Deg. C to +55 Deg. C.

c) During VSC ORU operating conditions, the heat dissipation of the VSC ORU shall be a maximum of 17.2 Watts, and a minimum of 10 Watts.

d) During VSC ORU non–operating conditions, the heat dissipation of the VSC ORU shall be a minimum of 0 Watts, excluding heater dissipation.

e) The VSC ORU to truss mounting bracket thermal conductance shall be no less than 5 Watts/Deg. C and no greater than 10 Watts/Deg. C.

f) The VSC heater control set points shall have the following characteristics:

i) Set point ON at –25 Deg. C, OFF at –20 Deg. C.

ii) Set point accuracy $\pm$3 Deg. C.

iii) Hysteresis 5 Deg. C.

iv) Hysteresis accuracy ±2 Deg. C.

H3.2.2.8.2 VSC ORU TO MODULE MOUNTING BRACKET THERMAL INTERFACES

a) The VSC non–operating temperature limits at the VSC ORU, shown in Figure H3.2.1.8.2–1, shall be within the range of **TBR** (–50 Deg. C. to +85 Deg. C).

b) The VSC operating temperature limits at the VSC ORU, shown in Figure H3.2.1.8.2–1, shall be within the range of **TBR** (–30 Deg. C to +55 Deg. C).

c) During VSC ORU operating conditions, the heat dissipation of the VSC ORU shall be a **TBR** (maximum of 17.2 Watts, and a minimum of 10 Watts).

d) During VSC ORU non–operating conditions, the heat dissipation of the VSC ORU shall be a minimum of 0 Watts.

e) The SSMB shall provide a VSC bracket (adapter plate) to module mounting bracket thermal conductance of no less than **TBR** (6 Watts/Deg. C).

H3.2.2.9 ENVIRONMENTS

H3.2.2.9.1 ELECTROMAGNETIC EFFECTS

H3.2.2.9.1.1 ELECTROMAGNETIC COMPATIBILITY

The VSC interface with the SSMB shall meet the applicable requirements of SSP 30243.

H3.2.2.9.1.2 GROUNDING

The VSC interface shall meet the requirements of SSP 30240.

H3.2.2.9.1.3 BONDING

a) The VSC structural/mechanical interface shall meet the applicable requirements of SSP 30245.

b) Bonding provisions at the interface shall satisfy a Class H and R bond in accordance with the above reference document.

H3.2.2.9.1.4 CABLE AND WIRE DESIGN

The VSC cable and wire interface shall meet the requirements of SSP 30242.

H3.2.2.9.1.5 ELECTROSTATIC DISCHARGE

The VSC interface shall meet the electrostatic discharge requirements of SSP 30243.

H3.2.2.9.1.6 CORONA

The VSC interface shall meet the corona requirements of SSP 30243.

H3.2.2.9.2 LAUNCH VIBRATION

The VSC shall operate after exposure to the launch vibration levels as shown in Table H3.2.2.9.2–1.

H3.2.2.9.3 ON–ORBIT VIBRATION

The VSC shall operated while on–orbit during exposure to the vibration levels as shown in Table H3.2.2.9.3–1.

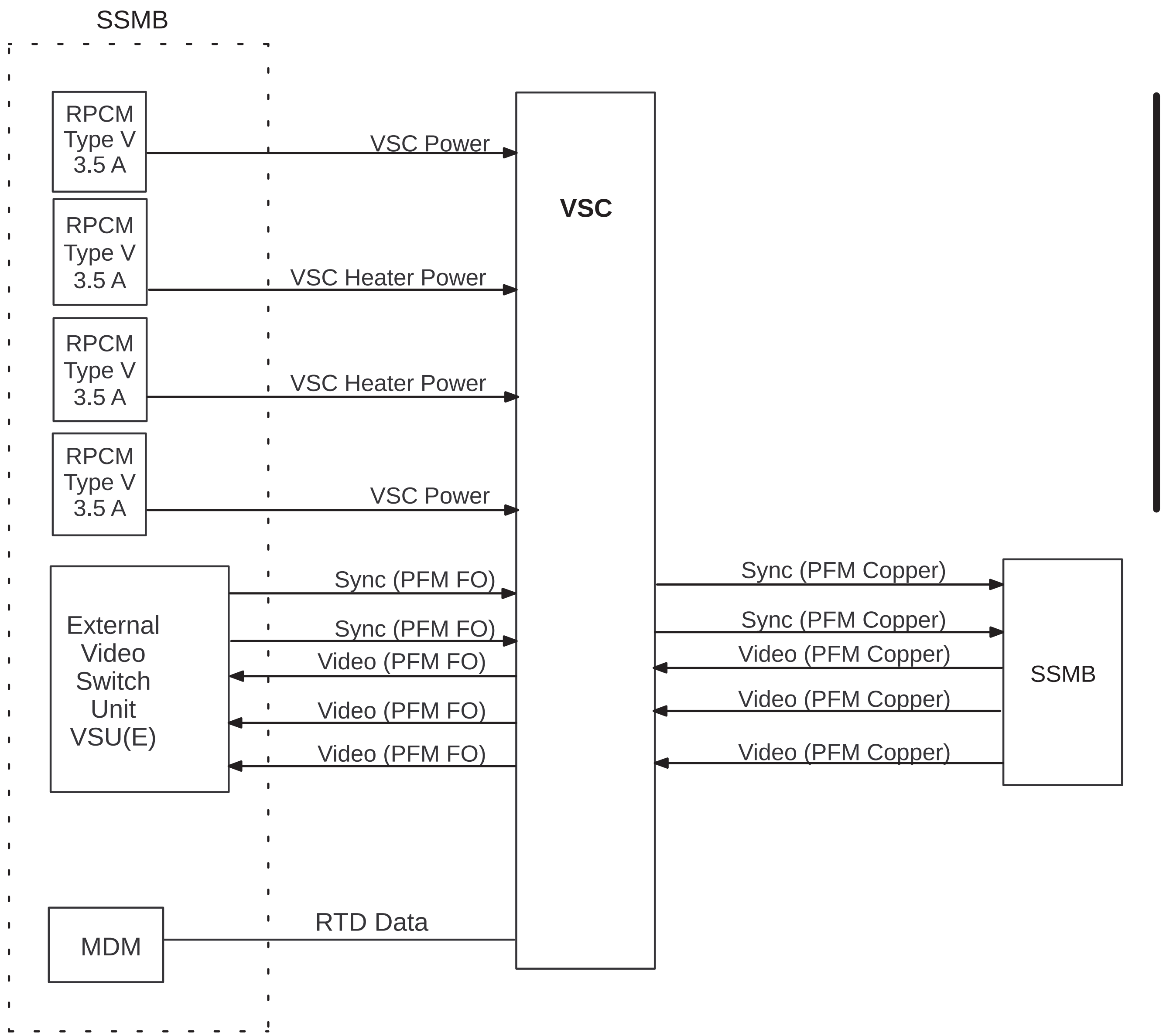
TABLE H3.1.5–1 SSMB TO VSC INTERFACE HARDWARE RESPONSIBILITIES

Interface Hardware Responsibilities	NASA Hardware	CSA Hardware
Truss Mounted VSC		
VSC ORU (including micro fitting, connectors, thermal blanket, and tie–down bolt)		X
Truss mounting bracket	X	
VSC Mounting Hardware Kit (includes Attraction Plates with mounting screws; Floating Insert)		X
SSMB utility distribution	X	
Module Mounted VSC		
VSC ORU (including micro fitting, connectors, thermal blanket, and tie–down bolt)		X
VSC bracket (adapter plate)		X
Module mounting bracket	X	
SSMB utility distribution	X	

TABLE H3.2.1.5–1 VSC TO SSMB ELECTRICAL INTERFACE PARAMETERS

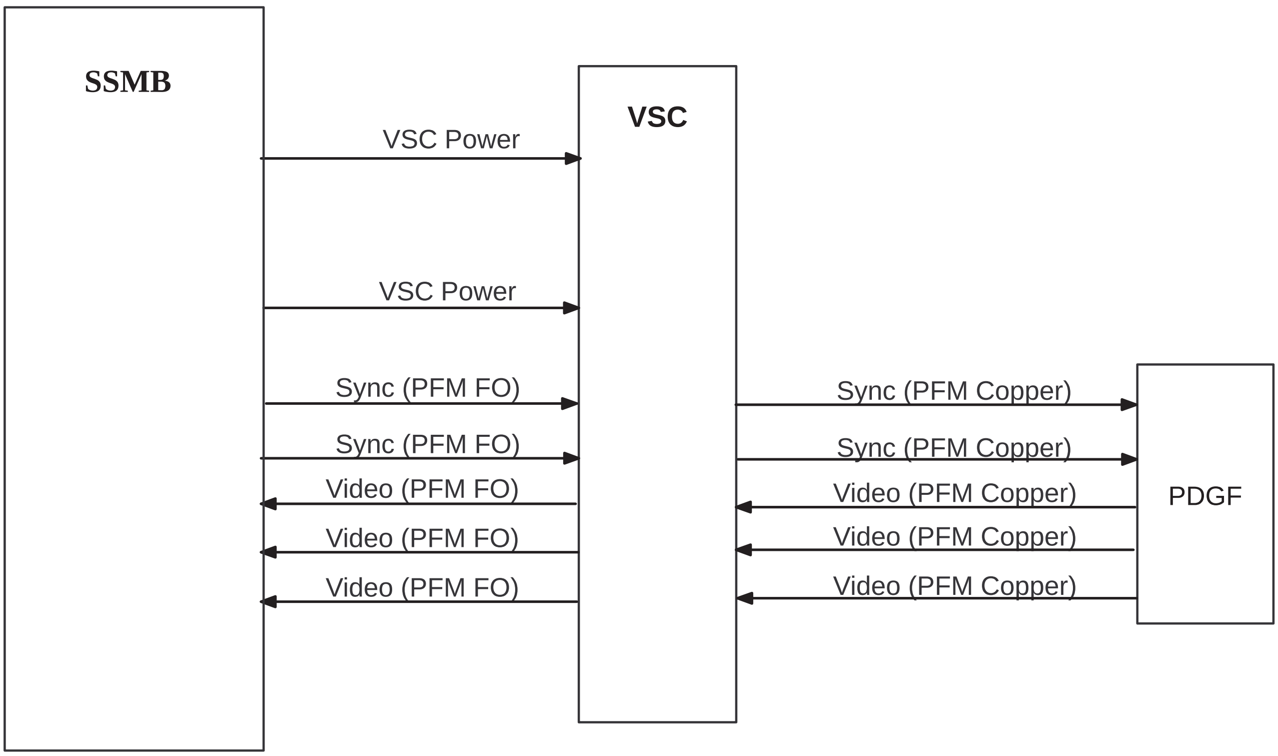
	Interface Voltage (volts)	**Current (amps)**	**Overcurrent Protection**
I–TRUSS–MOUNTED VSC			
Operating Power	113 TO 126	0 TO 0.15	NOTE 1
Heater Power	113 TO 126	0 TO 0.24	NOTE 1
II – MODULE MOUNTED VSC			
Operating Power	113 TO 126	0 TO 0.15	NOTE 2
Heater Power	N/A	N/A	N/A

Notes:
1) Protection shall be equivalent with SSP 30263:002 Type V (3.5 amps) RPCM standard
2) Protection shall be equivalent with SSP 30263:002, Type II (25 amps) RPCM standard.



Note: S0 requires 2 VSCs, one for each TUS Reel Assembly

FIGURE H3.2.1.5–1 TRUSS MOUNTED VSC TO SSMB ELECTRICAL INTERFACE DIAGRAM



Note: 1) No heater power is supplied for VSC's mounted on the modules.
2) SSMB does not require MDM interface for module mounted VSC.

FIGURE H3.2.1.5–2 MODULE MOUNTED VSC TO SSMB ELECTRICAL INTERFACE DIAGRAM

TABLE H3.2.1.7.1.2–1 SSMB/VSC SYNC AND CONTROL MINIMUM OPTICAL POWER

End to End Link Description		VSC Input Optical Power (dBm)
Sync Source	Sync Destination	
VSW 3 – sync	VSC TUS #1 – sync	–20.0
VSW 2 – sync	VSC TUS #1 – sync	–20.0
VSW 3 – sync	VSC TUS #2 – sync	–20.0
VSW 2 – sync	VSC TUS #2 – sync	–20.0

TABLE H3.2.1.7.1.4–1 SSMB/VSC VIDEO MINIMUM OPTICAL POWER

End to End Link Description		VSC Output Optical Power (dBm)
Video Source	Video Destination	
VSC TUS #1	VSW 1	–13.5
VSC TUS #1	VSW 2	–13.5
VSC TUS #1	VSW 3	–13.5
VSC TUS #2	VSW 3	–13.5
VSC TUS #2	VSW 2	–13.5
VSC TUS #2	VSW 1	–13.5

TABLE H3.2.1.7.2–1 SSMB/VSC COPPER VIDEO PARAMETERS

PARAMETER	MINIMUM	MAXIMUM
Video output from SSMB to VSC input	–15.0 dBm	+8.0 dBm
Sync output from VSC to SSMB input	+5.0 dBm	+9.0 dBm
Return Loss (Absolute)	16.0 dB	N/A

TABLE H3.2.2.9.2–1 VSC LAUNCH VIBRATION ENVIRONMENT

Frequency (Hz)	Level
20 – 260	0.2 g^2/Hz
260 – 330	–8.7 dB/Oct
330 – 350	0.1 g^2/Hz
350 – 2000	–2.6 dB/Oct
2000 Hz	0.022 g2/Hz
Composite	12.7 g RMS

Note: Three mutually perpendicular axes, duration is 180 seconds per axis.

TABLE H3.2.2.9.3–1 ON–ORBIT VIBRATION

Frequency (Hz)	Qualification Level G^2/Hz
10–50	0.0005
50–100	+3 dB/Octave
100–1000	0.001
1000–2000	–3 dB/Octave
2000	0.0005
Composite:	1.3 Grms
Duration:	10 Hours/year

Notes: (1) The accelerations shall be evaluated as acting one axis at a time in each of three orthogonal axes.
(2) The sinusoidal accelerations acts concurrently with a steady state acceleration of 0.4 g acting in any direction node. Use 0.2 g otherwise.

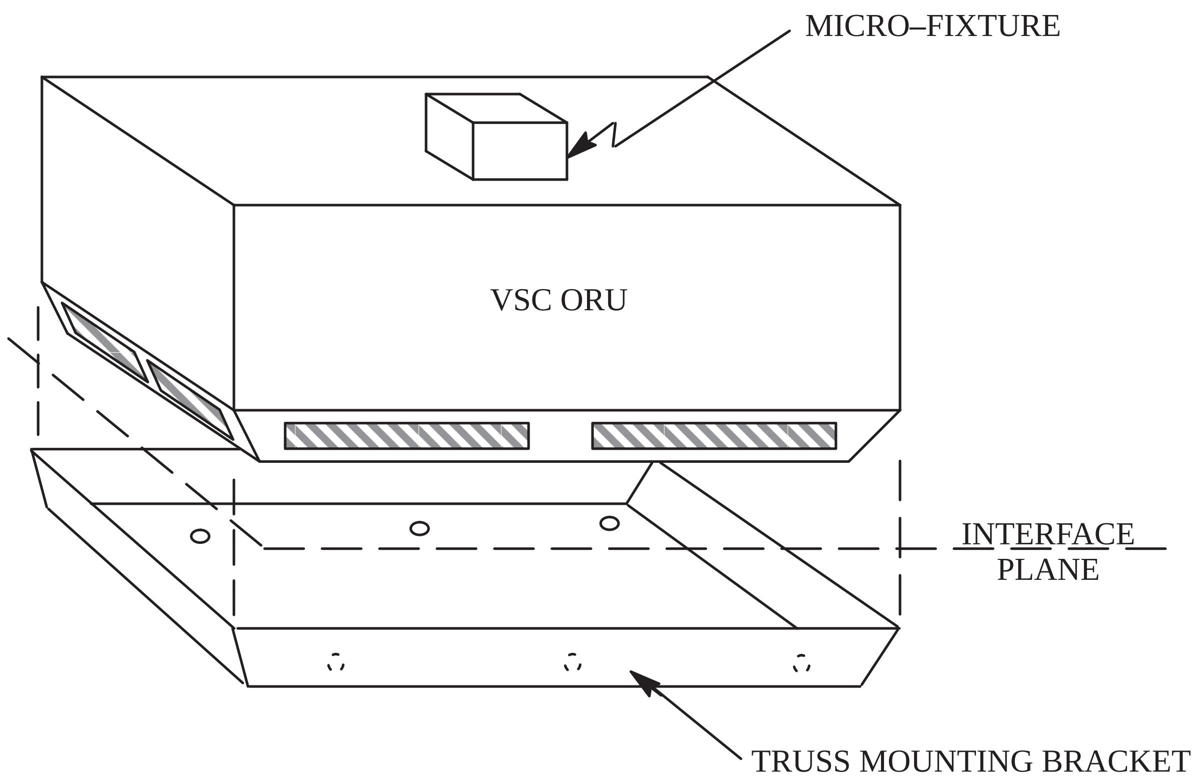


FIGURE H3.2.1.8.1–1 VSC ORU TO TRUSS MOUNTING BRACKET INTERFACE

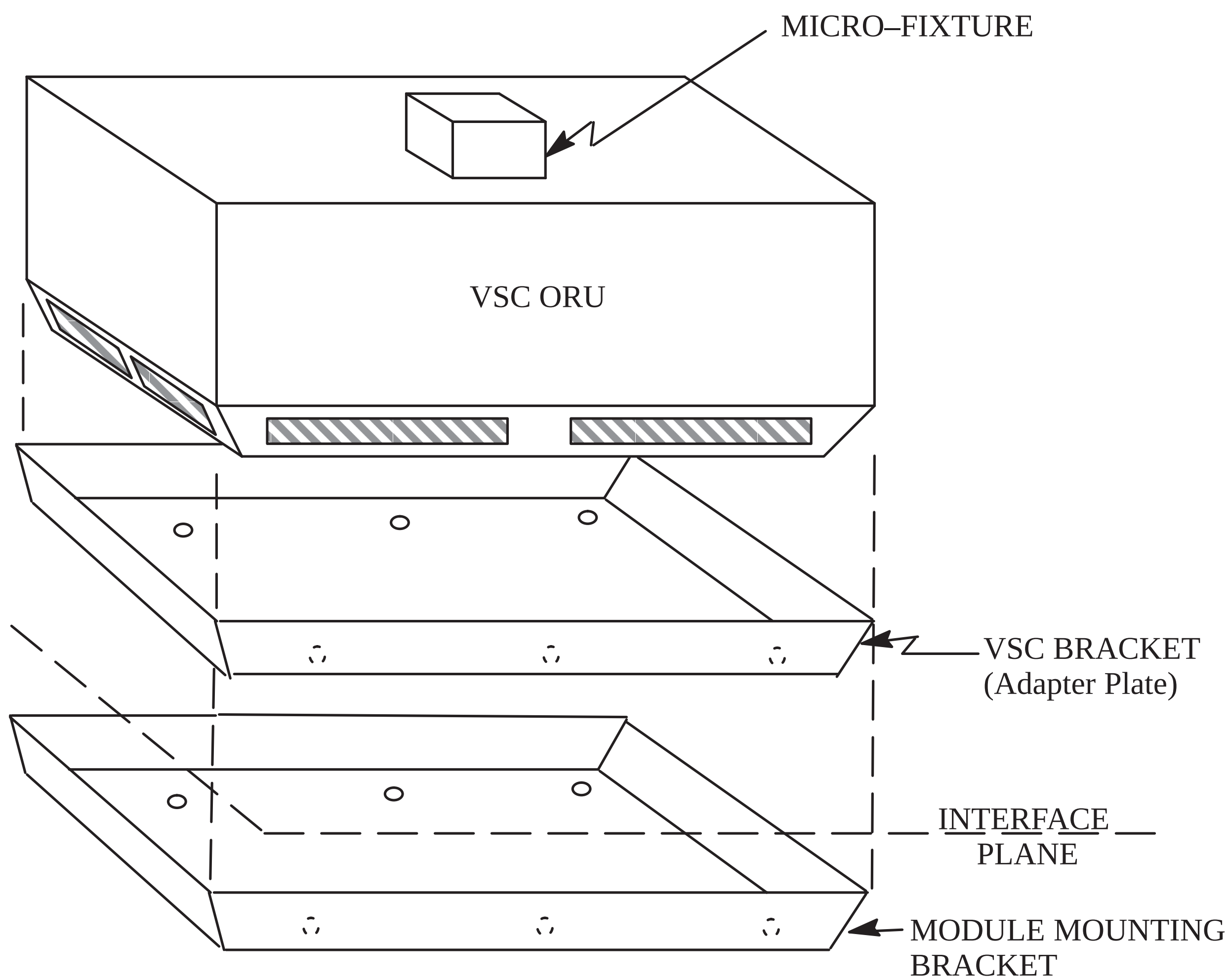


FIGURE H3.2.1.8.2–1 VSC ORU, VSC BRACKET TO MODULE MOUNTING BRACKET INTERFACE

APPENDIX A ABBREVIATIONS AND ACRONYMS

A.1 CONTROL AUTHORITY

Appendix A is not subject to SSCB change control. Responsibility for control of configuration management abbreviations and acronyms is delegated to Configuration Management.

This appendix will be reviewed as required and changes will be issued as replacement pages or by complete revision of the appendix as appropriate. All requested changes will be directed to Configuration Management.

A.2 ABBREVIATIONS AND ACRONYMS

A	Ampere
Amp	Ampere
AVU	Artificial Vision Unit
BDU	Back–Up Drive Unit
BHD	Bulkhead
C&C	Command & Control
C&DH	Command & Data Handling
CCD	Cursor Control Device
CETA	Crew Equipment Translation Aid
CSA	Canadian Space Agency
CL	Centerline
dBm	decibels meter
D&C	Display and Control
DCU	Display and Control Unit
dia	diameter
EMI	Electromagnetic Interference
EVA	Extravehicular Activity
FRGF	Flight Releasable Grapple Fixture

FSE	Flight Support Equipment
FSEGF	Flight Support Equipment Grapple Fixture
ft	feet
Hz	Hertz
ICD	Interface Control Document
in	inch
IP	International Partner
ISS	International Space Station
ITA	Integrated Truss Assembly
IVA	IntraVehicular Acivity
kN–m	kilo Newton–meter
kW	kilowatt
lbs	pounds
LSA	Launch Support Assembly
m	meter
MBS	MRS Base System
MCE	MSS Control Equipment
MRS	Mobile Remote Servicer
MSS	Mobile Servicing System
MT	Mobile Transporter
MTCL	MT Capture Latch
N	Newton
NASA	National Aeronautics and Space Administration
NSTS	National Space Transportation System
oct	Octave
ORU	Orbit–Replaceable Unit

PDGF	Power and Data Grapple Fixture
PFM	Pulse Frequency Modulated
psia	pounds per square inch absolute
PWP	Portable Workplatform
Rad	Radian
Ref	Reference
RMS	Remote Manipulator System
RPCM	Remote Power Control Module
RSS	root sum squared
RTD	Resistive Temperature Device
RWS	Robotics Workstation
SPDM	Special Purpose Dexterous Manipulator
SSCB	Space Station Control Board
SSMB	Space Station Manned Base
SSRMS	Space Station Remote Manipulator System
Sync	Synchronization
TBD	To Be Determined
TBR	To Be Resolved
ult	Ultimate
US	United States
USL	United States Laboratory
V	Volts
Vdc	Volts, direct current
VSC	Video Signal Converter
W	Watts
WIF	Worksite Interface Fixture

APPENDIX B ISSUE SHEETS

SSMB to MSS ICD, 42003 Part 1 ISSUES – Date Febraury 21, 1997

ACTION NUMBER: 42003–P1–01 – PG3 PDGF THERMAL

ISSUE DESCRIPTION :

PG3 was not supplied the PDGF thermal requirements until 1/21/97, IFM No: 4MSS17021–02. At this time, PG3 has designed, released, and manufactured to PG3 design assumptions. PG3 was required to make assumptions to keep PG3 and ISS Program schedules. PG3 assumptions/design constraints do not match the PDGF thermal requirements.

AFFECTED PARAGRAPHS :

D3.2.1.8.1 and D3.2.2.8.1

ACTION PLAN :

Attached

DUE DATE :

SSMB to MSS ICD, 42003 Part 1 ISSUES – Date Febraury 21, 1997

ACTION NUMBER: 42003–P1–02 – PG3 VSC THERMAL

ISSUE DESCRIPTION :

PG3 was not supplied the VSC thermal requirements until 1/21/97, IFM No.: 4MSS17021–02. At this time, PG3 has designed, released, and is manufacturing to PG3 design assumptions. PG3 was required to make assumptions to keep PG3 and ISS Program schedules. PG3 assumptions/design constraints do not match the VSC thermal requirements.

AFFECTED PARAGRAPHS :

H3.2.1.8.1 and H3.2.2.8.2

ACTION PLAN :

Attached

DUE DATE :

SSMB to MSS ICD, 42003 Part 1 ISSUES – Date Febraury 21, 1997

ACTION NUMBER: 42003–P1–03 – CSA VIDEO SYSTEM

ISSUE DESCRIPTION :

The current version of SSP 50002 does not contain the CSA Video Section (3.2.1.5.7.4) that is referenced in the ICD Video sections.

AFFECTED PARAGRAPHS :

D3.2.1.7.1, D3.2.2.67.1, F3.2.1.7.1, F3.2.2.7.1, H3.2.1.7.1.1 , H3.2.1.7.1.3, H3.2.1.7.2, H3.2.2.7.1.1, H3.2.2.7.1.3, H3.2.2.7.2

ACTION PLAN :

DUE DATE :

SSMB to MSS ICD, 42003 Part 1 ISSUES – Date Febraury 21, 1997

ACTION NUMBER: 42003–P1–05 – NON–COMPLIANT CONNECTORS

ISSUE DESCRIPTION :

Use of MIL–C–38999, Series III connectors violates toxic outgassing requirements of the Lab PIDS.

AFFECTED PARAGRAPHS :

G3.2.1.4 and G3.2.2.4

ACTION PLAN :

DUE DATE :

SSMB to MSS ICD, 42003 Part 1 ISSUES – Date Febraury 21, 1997

ACTION NUMBER: 42003–P1–06 – CLARIFICATION OF VIDEO SIGNAL CHARACTERISTICS/QUALITY

ISSUE DESCRIPTION :

Requirements in SSP 42003, Section G for the AVU video interface seem to be incomplete. The paragraphs in Section G point to SSP 50002, Paragraphs 3.2.1.1.5 and 3.2.1.4.2 which do not cover all of the parameters required by the AVU designers. The parameter of particular interest, the SNR at the interface to the AVU. Neptec have clearly specified their SNR requirements in terms of contrast. It seems as though Neptec's methods for calculating SNR may not be the same as NASA's.

AFFECTED PARAGRAPHS :

SSP 42003, C3.2.2.7.1

ACTION PLAN :

Must first determine an appropriate and agreed to means of calculating SNR to ensure that there are not misunderstandings. An analysis of the video signal at the interface to the AVU needs to be completed to determine the quality of the signal at that point in the system. The requirements in SSP 42003 must be more clearly specified to ensure that a signal of sufficient quality is delivered to the AVU which allows the AVU to meet its performance requirements.

DUE DATE : April 15, 1997

ISSUE FORM, SPACE STATION

Issue No. 42003–01–RA–01

Issue Title: MT/MBS Interface Load Spectrum During Translation

Initiator Name:	Robert Abercrombie	**Date:**	2/28/97
Org/Company:	McDonnell Douglas	**Initiator's Issue No:**	RA–01
Phone:	897–1172	**Problem Category:**	
Mailcode:	H017–D505		(Mandatory only)

Document ID:	SSP 42003, Revision F	**Page #:**	A3–4
Title:	SSMB to MSS ICD, Part 1	**Sec. #:**	A3
Date:	2/21/97	**Para. #:**	A3.2.1.3.2 g)
		Fig. #:	

Description of Issue:

WAS: g) The MT/MBS interface load spectrum during translation due to on–orbit loading environments excluding MT events shall be defined below: (TBR)
IS: g) The MT/MBS interface load spectrum during translation due to on–orbit loading environments excluding MT events shall be 30,000 cycles at the most critical loading conditions defined by item f.

In absence of direction for the MT/MBS interface load spectrum during translation MDA estimated one based on spectrum for stationary loads, A3.2.1.3.2 a) and a ratio of time spent stationary to time spent in translation. See attached table. The MT supplier has evaluated this spectrum and determined that it causes no impact to the MT design.

Recommendation:

Replace the 30,000 cycles at the most critical loading conditions defined by item f with the attached MDA derived spectrum or derive a new spectrum based on on–orbit analysis.

Impact if Recommendation Not Implemented:

The spectrum defined in Revision F will require significant re–analysis and possible design impacts.

Amplitude Tier (%)	Cycle Count
90–100	2
80–90	0
70–80	1
60–70	1
50–60	3
40–50	7
30–40	13,114
20–30	64,441
15–20	30,207
10–15	112,359
5–10	277,216
2.5–5	234,371

ISSUE FORM, SPACE STATION

Issue No. 42003–01–DE–01

Issue Title: MT Capture Bar & MTCL EVA Load Requirements

Initiator Name:	D. Erickson	Date:	2/26/97
Org/Company:	McDonnell Douglas	Initiator's Issue No:	DE–01
Phone:	896–5885	Problem Category:	
Mailcode:			(Mandatory only)

Document ID:	SSP 42003	Page #:	A3–6 & A3–11
Title:	SSMB to MSS ICD, Part 1	Sec. #:	
Date:	2/21/97	Para. #:	A3.2.1.3.3 & A3.2.3.3
		Fig. #:	

Description of Issue:

The referenced paragraphs deal with EVA Activity and are not a part of the MT/MBS Interface. Their inclusion in this ICD is inappropriate.

Recommendation:

Remove paragraphs A3.2.1.3.3 and A3.2.2.3.3

Impact if Recommendation Not Implemented:

ICD reflects requirements not appropriate for the MT/MBS interface.

APPENDIX C TBD LIST

TBD #	LOCATION	PAGE#	DATE CLOSED
1	A3.2.2.3.1 MBS STIFFNESS REQUIREMENTS	A3–9	2–21–97
2	A3.2.2.5.2 POWER INTERFACE CHARACTERISTICS (TRANSLATION MODE)	A3–10	2–21–97
3	C3.2.1.6 AVU CURSOR CONTROL DEVICE (CCD) DATA INTERFACE	C3–3	2–21–97
4	C3.2.1.7.1 VIDEO SYNC AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS	C3–5	2–21–97
5	C3.2.1.10 SOFTWARE INTERFACES	C3–5	2–21–97
6	C3.2.2.6.1 AVU CCD INTERFACE	C3–7	2–21–97
7	C3.2.2.7.1 VIDEO, SYNC, AND CONTROL TRANSMISSION AND SIGNAL CHARACTERISTICS	C3–8	2–21–97
8	C3.2.2.7.2 AVU UNIQUE OUTPUT VIDEO CHARACTERISTICS	C3–8	2–21–97
9	C3.2.2.10 SOFTWARE	C3–11	2–21–97
10	TABLE C3.1.5–1 AVU TO USL INTERFACE PROVISION RESPONSIBILITIES	C3–12	2–21–97
11	FIGURE C3.2.1.5–1 USL TO AVU ELECTRICAL INTERFACE DIAGRAM	C3–14	2–21–97
12	D3.2.1.8.1 PDGF THERMAL INTERFACES	D3–5	
13	D3.2.2.8.1 PDGF THERMAL INTERFACES	D3–9	
14	E3.2.1.1 PWP HARDWARE ENVELOPES	E3–1	6–15–96
15	E3.2.2.1 MBS AND SSRMS HARDWARE ENVELOPE	E3–2	2–21–97
16	F3.2.1.3.3 NSTS COUPLED LOADS	F3–3	2–21–97
17	F3.2.1.8 SSRMS LSA THERMAL INTERFACES	F3–5	2–21–97
18	F3.2.2.1 SSRMS HARDWARE ENVELOPES	F3–6	2–21–97
19	F3.2.2.3.1 STIFFNESS	F3–6	2–21–97
20	F3.2.2.3.2 ON–ORBIT INTERFACE LOADS	F3–6	2–21–97
21	F3.2.2.3.3 NSTS COUPLED LOADS	F3–6	2–21–97
22	F3.2.2.8 SSRMS THERMAL INTERFACES	F3–8	2–21–97
23	H3.2.1.7.2 SSMB COAXIAL SYNC, CONTROL AND VIDEO INTERFACES	H3–4	2–21–97
24	H3.2.1.8 THERMAL INTERFACES (H3.2.1.8.2–VSC ORU TO MODULE)	H3–4	
25	H3.2.2.2.1 VSC MASS	H3–5	2–21–97
26	H3.2.2.7.2 VSC COAXIAL SYNC, CONTROL AND VIDEO INTERFACES	H3–7	2–21–97
27	H3.2.2.8 THERMAL INTERFACES (H3.2.2.8.2 – VSC ORU TO MODULE)	H3–7	

TBD	MSS VIDEO INTERFACES	MULTI-PLE	
TBD	D3.2.1.3.3 INTERFACE LOAD SPECTRUM	D3–3	4/16/97